REFERENCE 137

Industrial Mineral Resources of New Brunswick - 1987

New Brunswick Department of Natural Resources and Energy
Minerals and Energy Division

1988

88-03936/

This report has been prepared by:

Minerals and Energy Division
Department of Natural Resources and Energy
Province of New Brunswick

Hon. Morris Green, Minister

1988

INDUSTRIAL MINERAL RESOURCES

OF

NEW BRUNSWICK - 1987

Prepared for the
8th Industrial Mineral International Congress
Boston, Massachusetts
April 24 - 27, 1988

Copies available by contacting:

Minerals and Energy Division
Department of Natural Resources
and Energy
P.O. Box 6000, Fredericton
New Brunswick E3B 5H1

1988

Report No.: Reference 137

Author: T.C. Webb

This report should be referenced in the following manner:

WEBB, T.C. 1988. Industrial mineral resources of New Brunswick - 1987. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Reference 137, 55 p.

CONTENTS

	Page
Introduction	1
General Geology of New Brunswick	3
Precambrian	6
Gneiss-Limestone-Dolomite-Quartzite-Argillite Sequence	6
Volcanic Rock Sequence	6
Cambrian	6
Ordovician	6
Silurian	6
Devonian	7
Intrusive Rocks	7
Carboniferous	7
Mississippian	7
Pennsylvanian	8
Triassic	8
Pleistocene	8
Industrial Minerals	8
Potash	8
Discovery	8
Potash Resource Policy	9
Geology	9
Development	12
Potash Company of America, Inc.	12
Denison-Potacan Potash Company	16
BP Resources Canada Ltd. (Selco Division)	17
New Brunswick Potash - Advantages and Opportunities	19
Silica	21
Chaleur Silica Limited	22
Sussex Silica Inc.	22
Sulphur	22
Brunswick Mining and Smelting Corporation Limited (Fertilizer and Smelter Division)	22
Gypsum	22
Fluorite	25
Glauberite	25
Barite	26
Marl	26
Graphite	26
Diatomite	26
Beryl	27
Limestone and Dolomite	27
History	27
Geology and Distribution	27

Contents (continued)

Reserves 29
Development 30
Brookville Manufacturing Company 30
Havelock Lime 30
Lafarge Canada Inc. 30
Elmtree Resources Ltd. 32
Upper Kent Lime Works Ltd. 34
Peat 34
Aggregate Resources 37
Crushed Stone 38
Sand and Gravel 38
Ablation Till 38
Ice-contact stratified Drift 38
Glaciofluvial Outwash 39
Lacustrine Sediments 39
Ancient Alluvial Deposits 40
Shale and Clay Products 40
Dimension and Ornamental Stone 40

Industrial Mineral Resource Management 41
Minerals 41
Aggregate and Peat 42

Appendix 1. Minerals and Energy Division Staff who can Provide Information on Industrial Mineral Resources and Development Opportunities in New Brunswick 45

Appendix 2. Producers and Potential Producers of Industrial Minerals in New Brunswick 49

Table 1. The Mining Act of New Brunswick: Summary of Mining Rights 43

ILLUSTRATIONS

Figure 1. Value of mineral production in New Brunswick, 1953 to 1987 1
2. Estimated contribution of industrial minerals to New Brunswick's mineral industry in 1987 2
3. Industrial mineral producers in New Brunswick 4
4A. General geology of New Brunswick 5
4B. Pie chart showing the distribution of mineral deposits and occurrences by geologic system 5
5. The drilling of Plumweseep No. 1, the potash discovery hole (1970) 10
6. Distribution of Windsor Group and major Carboniferous tectonic elements 11

Contents (continued)

Figure 7. General stratigraphy of the Windsor Group evaporites in the Moncton Subbasin, New Brunswick 12
8. Comparison of New Brunswick and Saskatchewan potash deposits ... 13
9. Potash mining leases in New Brunswick 14
10. The Potash Company of America, Inc. mine and concentrating facility, 5 km east of Sussex, New Brunswick 15
11. Potash ship-loading terminal at the Port of Saint John, New Brunswick 16
12. The Denison-Potacan Potash Company mine site, 20 km south of Sussex, New Brunswick 18
13. Railway line linking Denison-Potacan with the Port of Saint John, less than 60 km away 18
14. Selected industrial mineral occurrences in New Brunswick 20
15. The Sussex Silica Inc. property, 16 km south of Sussex, New Brunswick 23
16. Brunswick Mining and Smelting Corporation Limited smelter at Belledune, New Brunswick 23
17. Brunswick Mining and Smelting Corporation Limited fertilizer plant at Belledune, New Brunswick 24
18. General distribution of limestone-bearing rocks in New Brunswick 28
19. Brookville Manufacturing Company Ltd. quarry at Saint John, New Brunswick 31
20. Havelock Lime (a Division of Dickenson Mines Ltd.) processing facility at Havelock, New Brunswick 31
21. The Lafarge Canada Inc. cement plant, 3 km east of Havelock, New Brunswick 33
22. The Elmtree Resources Ltd. quarry, 20 km north of Bathurst, New Brunswick 33
23. Distribution of peatlands in eastern New Brunswick that are leased or have development potential 36
24. Brunswick Ready Mix Concrete Ltd. (Aggregate Division) property, 30 km north of Saint John, New Brunswick 39

ABBREVIATIONS USED IN TEXT

m	metre (1 m equals 3.280 84 feet)
m^2	square metre
km	kilometre (1 km equals 0.621 371 mile)
km^2	square kilometre
ha	hectare (1 ha equals 2.471 054 acres)
t	tonne (1 t equals 1.102 311 short tons)
tpa	tonnes per year

INDUSTRIAL MINERAL RESOURCES OF NEW BRUNSWICK 1987

INTRODUCTION

New Brunswick's mineral industry began in the early 1600s with the production of coal, gypsum and building stone. In the middle to late 1800s, hydrocarbons, copper, antimony, iron, manganese, limestone, and building stone achieved prominence. Oil, gas, coal, gypsum and peat moss were the mainstays of production until 1964, when base metals (lead, zinc and copper) began contributing to the Province's economy. Since 1984, potash, salt, and gold have added to the diversity and strength of New Brunswick's mineral industry.

The mineral industry is a major contributor to New Brunswick's economy, and one of the fastest growing industries. Its growth is indicated in the total value of minerals produced, which has increased from $11 700 000 in 1953 to about $701 000 000 in 1987 (Figure 1). The industry directly employs more than 4500 people and contributes approximately 8% to the Province's gross domestic product. At the present time, metals (including zinc, silver, lead, copper, gold, bismuth, cadmium, and antimony) contribute about 70% of the total value of minerals produced. Preliminary figures for the value of industrial mineral production (including cement, lime and various aggregates) was about $186 000 000 (Cdn) in 1987 compared to $153 000 000 in 1986 (Figure 2). This represented a 20% increase over the previous year. Potash and peat accounted for most of the increase. In 1987, industrial mineral production accounted for 27% of the total value of mineral production.

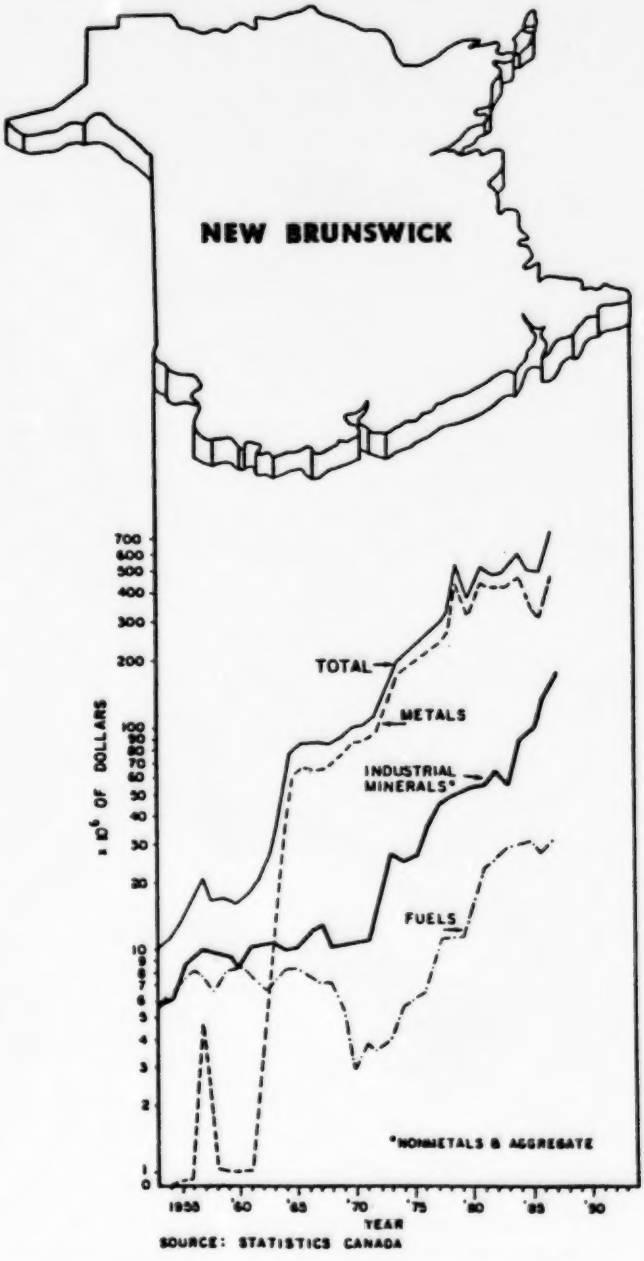


FIGURE 1. Value of mineral production in New Brunswick, 1953-1987.

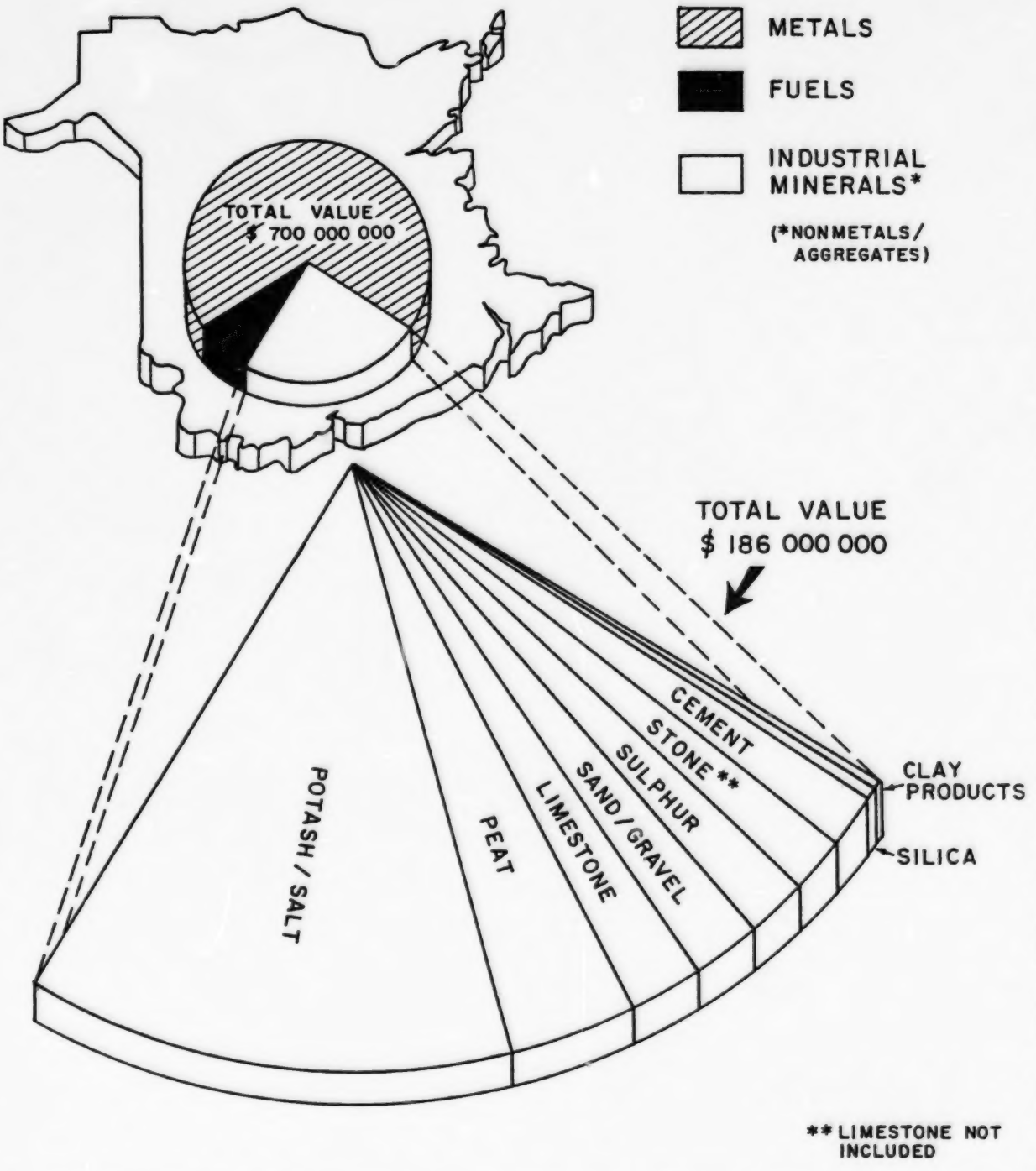


FIGURE 2. Estimated contribution of industrial minerals to New Brunswick's mineral industry in 1987 (source: Statistics Canada, 1987).

The mining of potash near Sussex has made industrial minerals a major contributor to the total value of mineral production. Other industrial minerals produced in New Brunswick include silica, peat, limestone, gypsum, sulphur, salt, sand, gravel, crushed stone, dimension stone, and brick shale (Figure 3). In addition, the unutilized resource includes barite, fluorite, celestite, graphite, diatomite, marl, glauberite, and others. Energy resources produced are coal, natural gas, and petroleum.

More than $2 000 000 000 of new capital has been invested in the exploration, development, production, smelting, and refining sectors between 1953 and 1987. An additional $500 000 000 could be invested within the next decade. In addition to the revenue generated through mining taxes and royalties, federal and provincial corporate and sales taxes, municipal taxes, and personal income taxes, many thousands of dollars are spent annually by mining companies for local goods and services.

By the year 2000, the value of mineral production in New Brunswick should approach $1 000 000 000 and direct employment in the mining industry should be 5000-6000 people with an equivalent number employed in related service, supply, and transportation industries.

When compared to other provinces and territories in Canada, New Brunswick ranks ninth in the total value of minerals produced. The Province ranks first in the production of bismuth and antimony, second in potash and peat moss, and third in zinc, lead, and silver. On the basis of dollar value per square kilometre, the Province ranks second to Alberta.

New Brunswick's contribution to world mineral production is approximately 3.5% for lead, 4.5% for zinc, 6% for antimony, and 4.5% for potash.

Despite the weak demand and low metal prices of the early 1980s, New Brunswick's mineral industry has continued to grow and diversify. Recent discoveries of gold, silver, base metals, limestone, dolomite and silica have been made, and a third potash deposit may be developed in the southern part of the Province. There is a great potential for growth in all segments of the industry because of the diversity of minerals available, recent advancements in technology, and a general improvement in consumption of mineral products.

GENERAL GEOLOGY OF NEW BRUNSWICK

New Brunswick is well endowed with a wide variety of metals, industrial minerals, structural materials and mineral fuels, reflecting perhaps its complex geological history. The Province produces more than 21 mineral-related commodities.

New Brunswick is underlain by rocks of Precambrian to Triassic age (Figure 4A). Large areas of sedimentary and volcanic rocks occur in the west and northwest. Carboniferous strata predominate in the east.

Most major geologic systems are represented in the Province. Their significance as host rocks for mineral deposits is summarized in Figure 4B.

Gently rolling hills typify the New Brunswick landscape; however, the topography is more rugged in the northern and southern parts of the Province. Outcrops are generally restricted to stream and river banks, roadcuts and the crests of

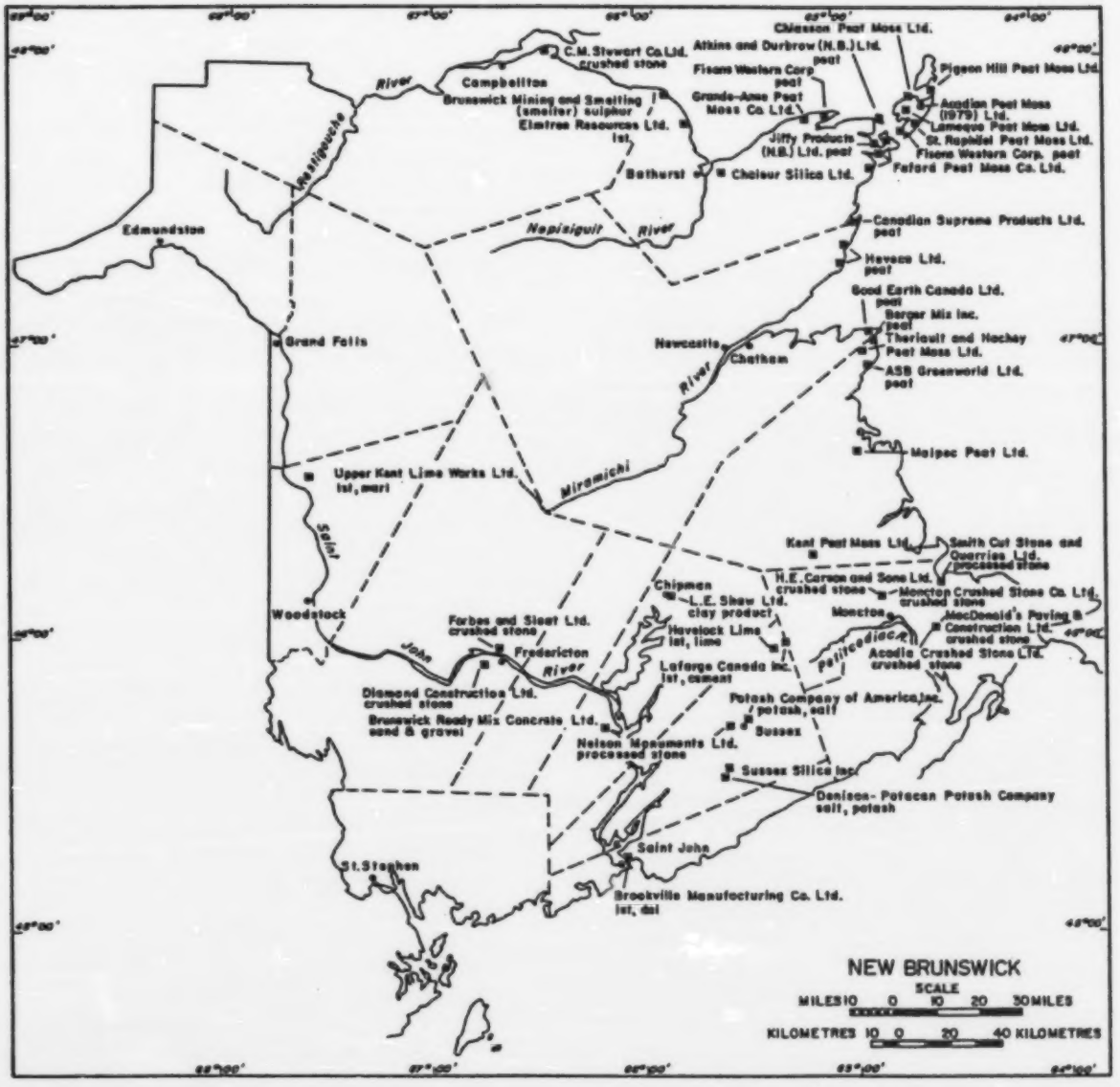
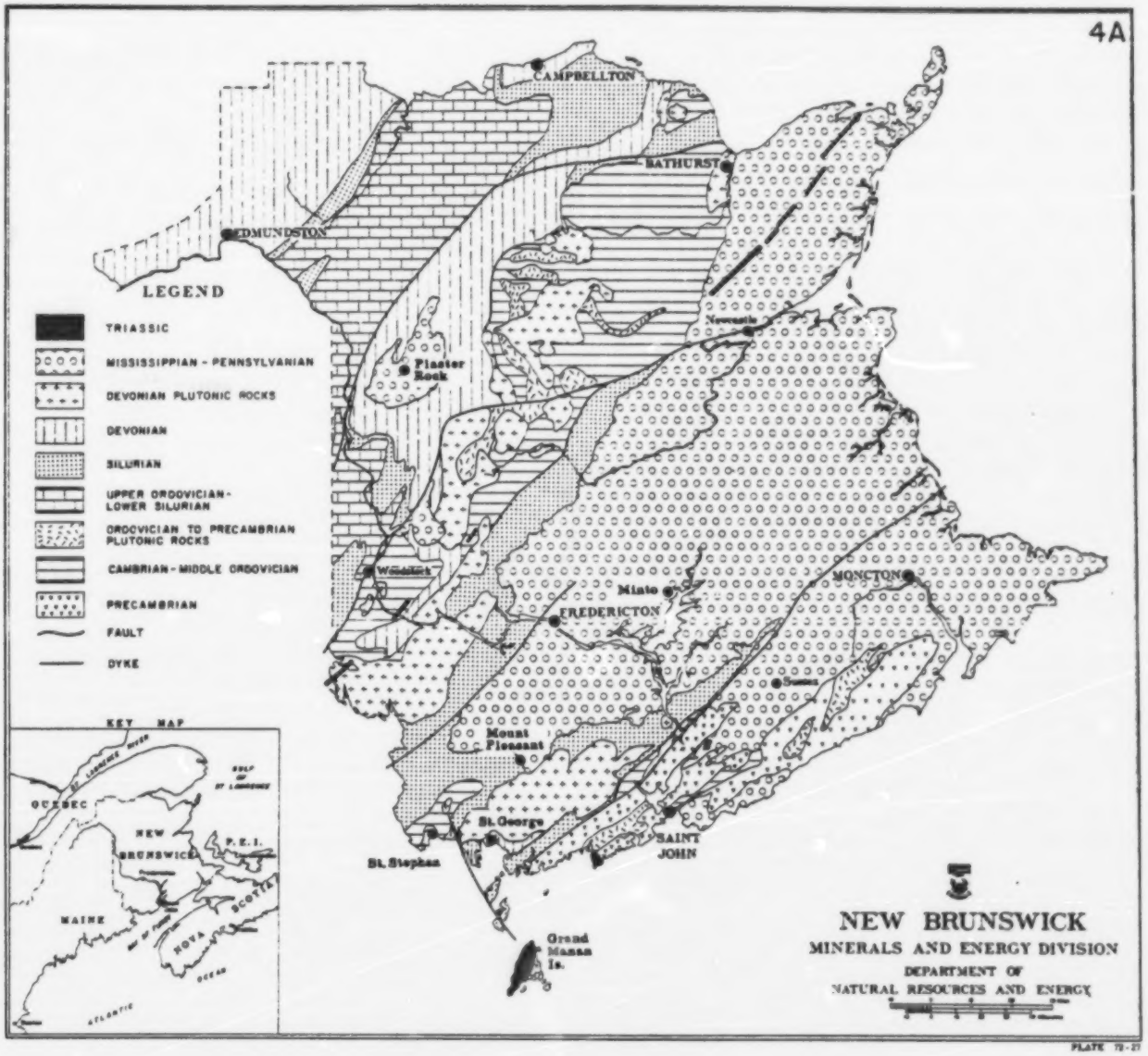

C.M. Stewart Co. Ltd. crushed stone
Campbellton
Brunswick Mining and Smelting (smelter) sulphur
Elmtree Resources Ltd. lst.
Bathurst
Chaleur Silica Ltd.
Atkins and Durbrow (N.B.) Ltd. peat
Fisons Western Corp. peat
Grande-Anse Peat Moss Co. Ltd.
Chiasson Peat Moss Ltd.
Pigeon Hill Peat Moss Ltd.
Acadian Peat Moss (1979) Ltd.
Lameque Peat Moss Ltd.
St. Raphael Peat Moss Ltd.
Fisons Western Corp. peat
Feford Peat Moss Co. Ltd.
Jiffy Products (N.B.) Ltd. peat
Canadian Supreme Products Ltd. peat
Hevesa Ltd. peat
Good Earth Canada Ltd. peat
Berger Mix Inc. peat
Theriault and Hachey Peat Moss Ltd.
ASB Greenworld Ltd. peat
Malpec Peat Ltd.
Kent Peat Moss Ltd.
Smith Cut Stone and Quarries Ltd. processed stone
H.E. Carson and Sons Ltd. crushed stone
Moncton Crushed Stone Co. Ltd. crushed stone
MacDonald's Paving & Construction Ltd. crushed stone
Acadia Crushed Stone Ltd. crushed stone
Moncton
Petitcodiac
Chipman
L.E. Shaw Ltd. clay product
Havelock Lime lst, lime
Laforge Canada Inc. lst, cement
Potash Company of America, Inc. potash, salt
Sussex
Sussex Silica Inc.
Denison-Potacan Potash Company salt, potash
Nelson Monuments Ltd. processed stone
Forbes and Sloat Ltd. crushed stone
Fredericton
Diamond Construction Ltd. crushed stone
Brunswick Ready Mix Concrete Ltd. sand & gravel
Woodstock
Grand Falls
Edmundston
Upper Kent Lime Works Ltd. lst, marl
Newcastle
Chatham
Miramichi River
Nepisiguit River
Restigouche River
Saint John River
Saint John
St. Stephen
Brookville Manufacturing Co. Ltd. lst, dol
NEW BRUNSWICK
SCALE
MILES 10 0 10 20 30 MILES
KILOMETRES 10 0 20 40 KILOMETRES

FIGURE 3. Industrial mineral producers in New Brunswick.



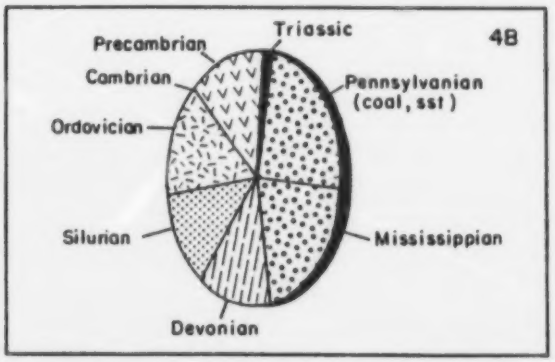


FIGURE 4A. General geology of New Brunswick.

FIGURE 4B. Pie chart showing the distribution of mineral deposits and occurrences by geologic system.

hills. Bedrock mapping and associated geologic interpretations require a considerable amount of skill, and are commonly supplemented by geophysical and geochemical surveys, and drilling.

PRECAMBRIAN

Strata of presumed Precambrian age outcrop only in southern New Brunswick near Saint John, the Province's largest city, and along the Bay of Fundy coast. Two main lithologic units have been identified: a gneiss-limestone-dolomite-quartzite-argillite sequence, and a complex assemblage of volcanic flows, tuffs and sedimentary rocks. Both are cut by felsic to mafic dykes and sills of Precambrian and/or Palaeozoic age.

Gneiss-Limestone-Dolomite-Quartzite-Argillite Sequence

Complexly folded and faulted strata of this unit are well exposed in a series of narrow belts several kilometres southwest and northeast of Saint John (Figure 4A). Similar rocks occur on Grand Manan Island near the mouth of the Bay of Fundy. Beds of limestone, dolomite, and quartzite predominate near the stratigraphic base of the sequence, whereas quartzite and argillite are most abundant near the top. The exact relationship between this major unit and overlying younger rocks is not clear because contacts are commonly faulted.

Volcanic Rock Sequence

Rhyolitic and andesitic flows and related sedimentary rocks of probable Precambrian age outcrop in two subparallel belts southwest and northeast of Saint John (Figure 4A).

Small sills and dykes of granitic and gabbroic composition intrude both sequences. Their age is uncertain.

CAMBRIAN

Small, isolated exposures of Cambrian sedimentary rocks occur mainly in the vicinity of Saint John (Figure 4A). Red conglomerate and white quartzite occur near the base of the Cambrian. Shale, siltstone and some limestone predominate in the upper part of the sequence.

ORDOVICIAN

Ordovician rocks underlie large areas of New Brunswick, extending from Bathurst in the northeast to Woodstock in the southwest, and near St. Stephen (Figure 4A). Parts of northwestern New Brunswick may also contain Ordovician strata. In northern New Brunswick, greywackes and slates are overlain by cherty iron formations, thin basaltic flows, and great thickesses of rhyolitic tuffs and flows. These rocks host the extensive pyritic zinc-lead-copper deposits of the Bathurst-Newcastle area. All are complexly folded. Sedimentary rocks predominate to the southwest where deformation appears to have been less intense. Slates, quartzites, and minor basic flows occur near St. Stephen and have also been mapped in the vicinity of Saint John.

SILURIAN

Strata of Silurian age underlie large areas in the western, central, and southern parts of New Brunswick (Figure 4A). In the northwest, folded Silurian calcareous and argillaceous sedimentary rocks predominate. Volcanic rocks are more abundant to the east, and occupy the western and northern flank of the Ordovician folded belt. In contrast to Ordovician strata, which reflects deepwater deposition, these volcanics and related sedimentary

rocks reflect a terrestrial to subaqueous environment. Rhyolites, trachytes, andesites, shales, and red conglomerates are common. In places, dykes, sills, and mafic to felsic intrusives that are related to these flows have associated vein deposits of zinc, lead, copper, and silver.

Near the Canada-United States border, red-green manganiferous iron formations are interbedded with the calcareous sedimentary rocks. Lithic and quartzose greywackes occur on the eastern flank of the Ordovician strata, and extend southward toward the Bay of Fundy.

In general, Silurian rocks are steeply folded. Volcanic rocks, in most places, are tilted and block faulted, which increase the difficulty of tracing individual units over great distances.

DEVONIAN

Sedimentary rocks of Devonian age are restricted to the northern and southern parts of the Province (Figure 4A). Shales, sandstones and volcanic rocks are most common; red conglomerates occur locally. Silurian and Devonian rocks appear to be structurally conformable. They have been folded and faulted, and intruded by granitic, dioritic, and gabbroic batholiths and stocks.

In the Bathurst area, Lower Devonian shales are overlain by basaltic to andesitic flows and tuffs. In the St. Stephen area, shales, greywackes and conglomerates overlie Silurian volcanic strata. The widespread folding that followed the deposition of these rocks has been termed the Acadian orogeny.

Intrusive Rocks

Batholiths and stocks of granitic composition are common in New Brunswick, especially in the area between Bathurst and Woodstock (Figure 4A). Quartz monzonites predominate. Quartz diorites, granodiorites, gabbros and ultramafic rocks occur locally. Gneissic quartz monzonites have been mapped in the central part of the Province. Tungsten, tin, molybdenum and fluorspar are often found associated with Devonian granitic rocks.

A widespread unconformity separates older sedimentary and volcanic rocks from Upper Devonian-Carboniferous conglomerates and sandstones.

CARBONIFEROUS

Strata of Carboniferous age underlie more than half of New Brunswick, particularly in the central, eastern and southeastern parts of the Province (Figure 4A). Isolated outliers occur at Plaster Rock, near Woodstock, west of Fredericton, and south of Dalhousie.

In contrast to the older rocks, Carboniferous strata are predominantly of continental derivation. They include red, green, and grey coal-bearing sandstones and conglomerates deposited after the Acadian orogeny. Limestone, gypsum, salt and petroliferous shales occur locally. Lower Carboniferous rocks in the southern part of the Province are folded and faulted; however, most Upper Carboniferous strata are flat-lying to gently dipping.

Mississippian

Late Devonian and early Mississippian strata form a sequence of conglomerates and sandstones, limestones and evaporites. Rhyolitic and andesitic flows were also laid down to the west near Mount Pleasant (Figure 4A). Porphyry-type tungsten, molybdenum, tin, fluorspar, and uranium mineralization is associated with these rocks.

Pennsylvanian

Local unconformities separate Mississippian evaporites from younger clastic sedimentary rocks. The main tectonostratigraphic boundary occurs at the top of the evaporites but the overlying strata are, in places, considered Upper Mississippian in age.

A distinctive quartz-pebble conglomerate occurs near the base of the Pennsylvanian in New Brunswick. It is overlain by comparatively thin reddish brown and greyish green sandstones throughout most of east-central New Brunswick. The well-known bituminous coal deposits of the Minto area (Figure 4A) occur within these rocks. Uraniferous and cupriferous sandstones are also present locally.

TRIASSIC

Isolated exposures of bright red conglomerate, sandstone, and shale occur along the Bay of Fundy coast (Figure 4A). Basic volcanic flows and sills with native copper, amethyst and zeolites occur on Grand Manan Island. Farther to the north, many dykes may be as young as Triassic. An extensive post-Pennsylvanian dyke has been mapped in the northeastern part of the Province.

PLEISTOCENE

The strata in New Brunswick are overlain by postglacial deposits of Pleistocene age. Deposits of economic importance include sand, clay, gravel, peat, marl, diatomite, bog iron, bog copper, and bog manganese.

INDUSTRIAL MINERALS

In New Brunswick, industrial minerals comprise nonmetallic minerals and structural materials. Nonmetallic minerals include peat, potash, silica, salt, sulphur, limestone, gypsum, barite, fluorite, celestite, graphite, diatomite, marl, and glauberite. Structural materials include clay products, cement, lime, sand and gravel, crushed stone, dimension stone, and brick shale.

POTASH

Discovery

The presence of potash mineralization in the Carboniferous basins of New Brunswick and other parts of Atlantic Canada had been suspected prior to 1971. This suspicion was based on the confirmed occurrence of high-order marine evaporites within Windsor Group rocks and the presence of many brine springs containing anomalous concentrations of potassium.

Although the region showed considerable promise, companies were not interested in extensive exploration projects. The overshadowing effect of the rapid development of potash resources in Saskatchewan (discovered in 1942) probably played a significant role in deterring exploration in this part of the country. A preliminary survey of geologic literature in the early 1960s indicated that, if found, a potash deposit would probably be of limited extent, and insufficient grade and thickness. It was also perceived that any potash would be found at depths prohibitive to mining. The oversupply of potash on the world markets throughout much of the 1960s also discouraged exploration attempts. These factors, in addition to the lack of well-defined target areas, made a systematic exploration programme a risky venture - one that most companies at that time were unwilling to accept.

Toward the end of the 1960s, the viability of establishing a chemical industry west of Saint John became a topic of some interest and concern to the New Brunswick government, which was eager to expand the industrial base of the Province's economy. One of the prime requirements of such an industry was the accessibility of high-grade salt, a basic ingredient in many chemical processes.

To identify a nearby source of salt, Provincial geologists outlined a number of exploration target areas in the vicinity of the town of Sussex. Areas proximal to major transportation links with Saint John were given priority, and a drilling programme was established that was jointly funded by the Canada Department of Regional Economic Expansion (DREE) and the New Brunswick Department of Natural Resources (DNR).

Early in 1971, two holes were drilled in an area just east of the town of Sussex into an elongated salt structure. Although both intersected high-grade salt, the first intersection of potash was in the hole near Plumweseep (Figure 5). In this hole, Plumweseep No. 1, a cumulative thickness of 20.7 m of sylvinite averaging 23.7% K_2O was intersected between 277 and 305 m below surface.

The unexpected success of Plumweseep No. 1 and an improvement in the supply/demand situation in world potash markets prompted the New Brunswick Department of Natural Resources to carry out additional potash exploration in the Sussex area in 1972. By utilizing gravity methods, a number of anomalies were delineated in areas having Windsor Group outcrops and possible subsurface salt structures. This work led to the drilling of three more government-funded holes in 1973, all within a 30 km radius of Sussex. As a result, potash was discovered in the Cassidy Lake-Salt Springs area and near Lower Millstream.

The hole drilled 30 km southwest of Sussex at Salt Springs intersected a substantial thickness of sylvinite, averaging 31.6% K_2O between 607 and 623 m below surface. The Lower Millstream hole, situated less than 10 km west of Sussex, confirmed the presence of potash-bearing evaporites at 925 m, but results were inconclusive as to its exact nature and significance.

Potash Resource Policy

Following the initial potash discovery at Plumweseep, the New Brunswick government invoked Crown ownership of potash and related minerals within the Province. In effect, this removed these minerals from the traditional prospecting and claim staking procedures as set out in the Province's Mining Act. A policy of inviting interested companies to bid on exploration and subsequent development rights for selected potash reservation areas was adopted.

Under this policy, three companies have entered into mining lease agreements with the Province since 1973. A similar request for proposals on a fourth area, east of Moncton, was invited in 1981; however, after drawing only a limited response, the government chose not to proceed with awarding exploration rights at that time.

Geology

New Brunswick potash deposits are of Mississippian (Viséan) age. They are intimately associated with Windsor Group marine sediments deposited in a number of subbasins within the broad Maritimes Basin, extending in a northeast direction from southern New Brunswick, through northern Nova Scotia to the southwestern shore of Newfoundland

FIGURE 5. The drilling of Plumweseep No. 1, the potash discovery hole (1971).

(Figure 6).

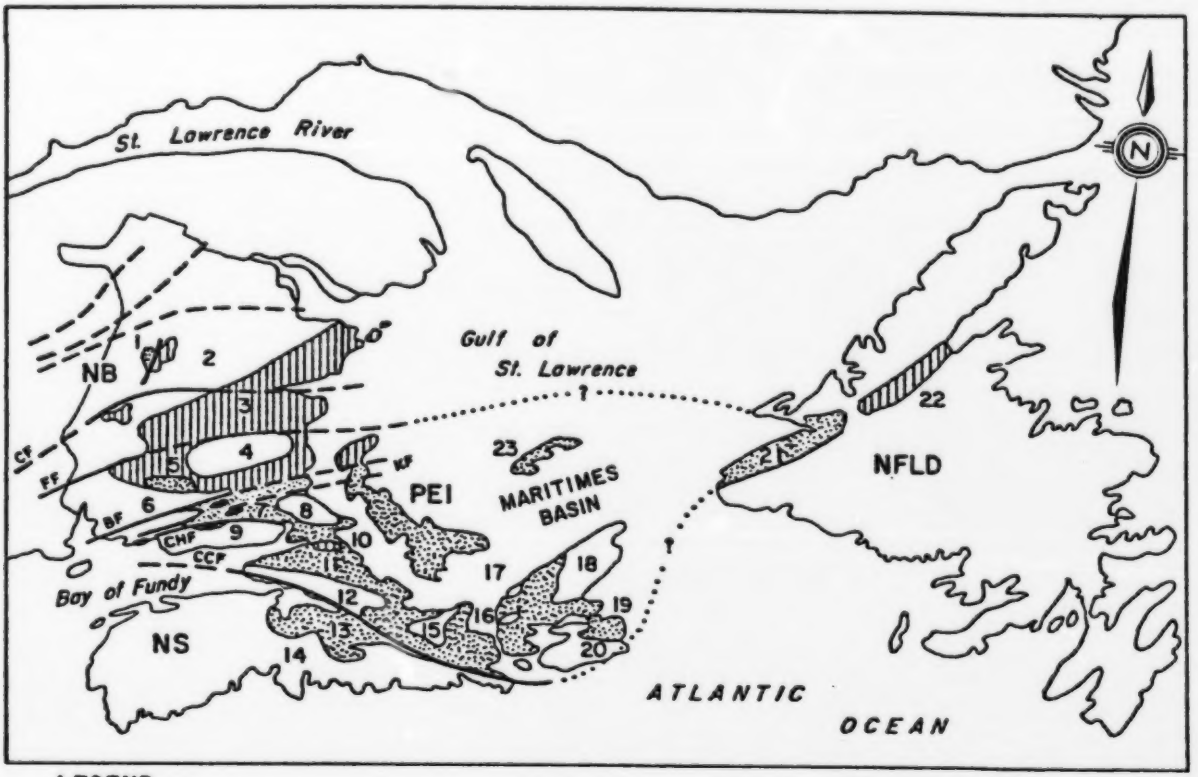
The Windsor Group in New Brunswick consists of a sequence (up to 300 m thick) of limestone overlain by anhydrite (gypsum), halite, and sylvinite/carnallite. Capping the evaporites are halite, claystone and clastics (Figure 7).

The most obvious differences between the potash deposits in Saskatchewan and New Brunswick are their contrasting thickness and extent (Figure 8). The resource in Saskatchewan is estimated to be 70 000 000 000 t of K_2O equivalent product, including 2 700 000 000 t classified as reserves[1]. It accounts for more than 50% of the total identified world resource. The New Brunswick resource is much smaller. The deposits are up to 30 m thick and occur at depths seldom exceeding 1000 m. Approximately 700 000 000 t of in situ potash ore is the estimated total for the New Brunswick deposits.

The deposits of Saskatchewan and New Brunswick also differ in their structural complexity. In Saskatchewan they are flat-lying, while in New Brunswick they have been subjected to varying degrees of internal folding. Although initially perceived as a possible

---

[1] Fuzesy, A. 1982. Potash in Saskatchewan. Saskatchewan Energy and Mines, Report 181, 44 p.



LEGEND

150 0 150
KILOMETRES

- Basement Highs
- Carboniferous Deposition (excluding Windsor Group evaporites)
- Carboniferous Deposition (including Windsor Group evaporites)
- Fault (defined, assumed)
- New Brunswick Potash Deposits

CARBONIFEROUS TECTONIC ELEMENTS

1. Plaster Rock Basin
2. Miramichi Geanticline
3. New Brunswick Platform
4. Minto Uplift
5. Marysville Subbasin
6. Kingston Uplift
7. Moncton Subbasin
8. Westmorland Uplift
9. Caledonia Uplift
10. Hastings Uplift
11. Cumberland Subasin
12. Cobequid Uplift
13. Minas Subbasin
14. Nova Scotia Platform
15. Antigonish Uplift
16. Antigonish - Mabou Subbasin
17. Mabou Uplift
18. Cape Breton Uplift
19. Sydney Subbasin
20. Sydney Uplift
21. St. George Subbasin
22. White Bay Subbasin
23. Magdalen Subbasin

FAULTS

CF	Catamaran Fault	KF	Kennebecasis Fault
FF	Fredericton Fault	CHF	Clover Hill Fault
BF	Belleisle Fault	CCF	Chedabucto - Cobequid Fault System

FIGURE 6. Distribution of Windsor Group and major Carboniferous tectonic elements (after Schenk 1969; Kelly 1967; Wade et al. 1977; and Martel 1987).

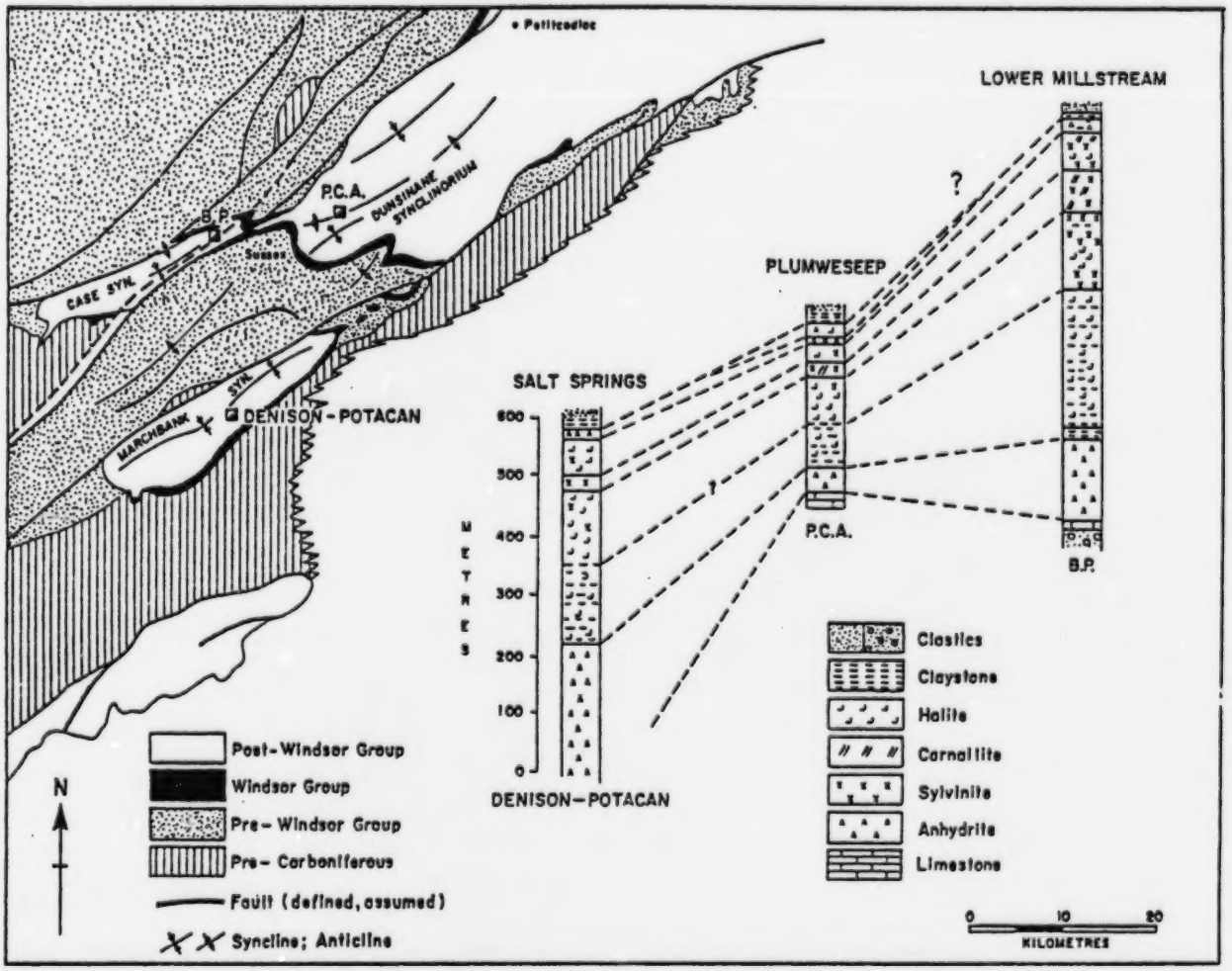


FIGURE 7. General stratigraphy of the Windsor Group evaporites in the Moncton Subbasin, New Brunswick.

deterrent to cost-effective mining, subsequent underground exploration and development have indicated that the scale and complexity of folding lie well within manageable limits.

The grade of New Brunswick's potash ore is comparable to that of Saskatchewan's, ranging from 22-28% K_2O.

Two of the three companies involved with potash development in the Province operate mines with associated processing and port storage facilities (Figure 9). A third company, which has recently signed a mining lease with the Province, has undertaken a feasibility study prior to making a decision to proceed on shaft sinking and underground exploration. Both are necessary before a production decision can be made.

Development

POTASH COMPANY OF AMERICA, INC. The Sussex area mine and concentrating facility of the Potash Company of America, Inc. (PCA) (Figure 10)

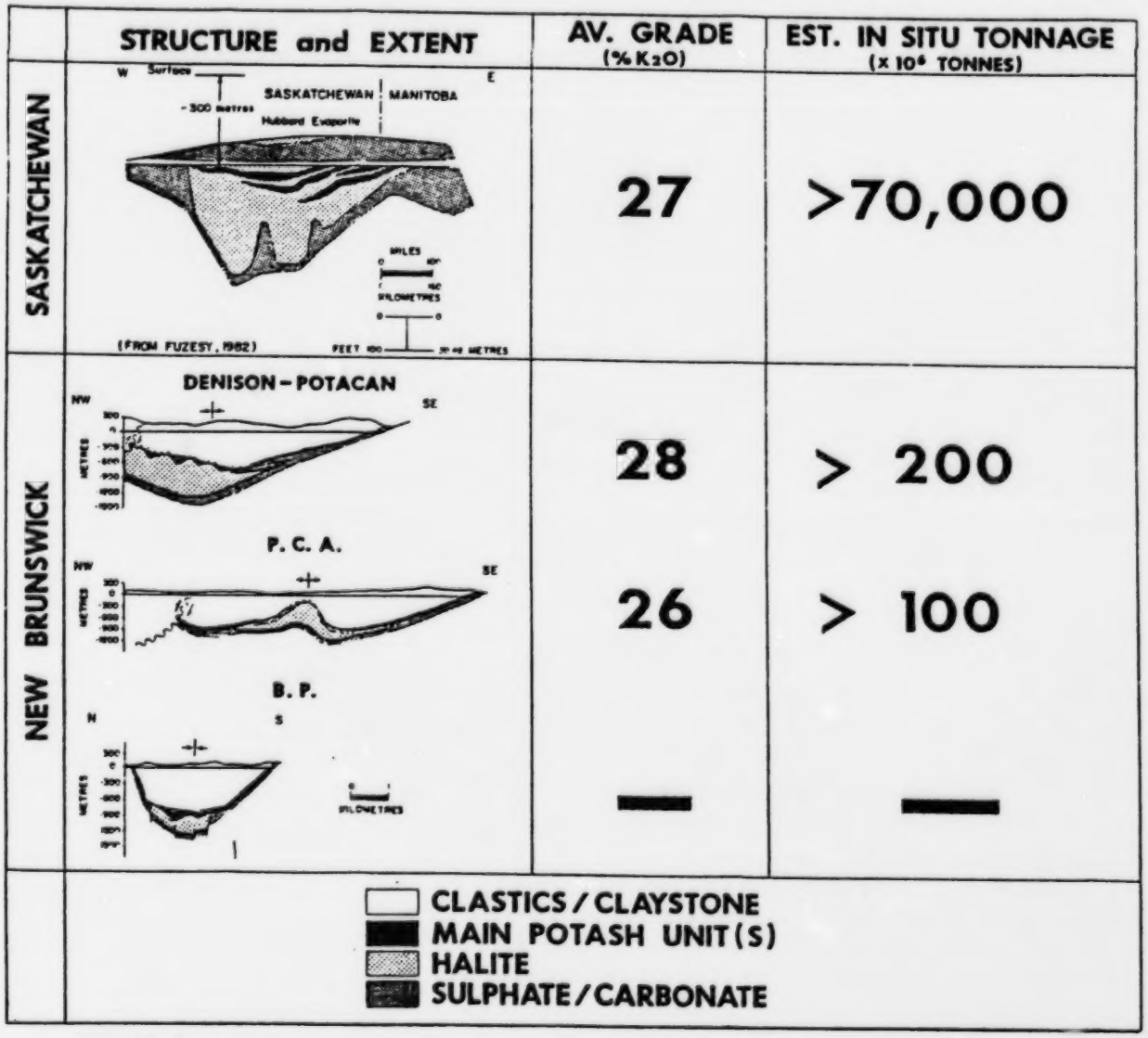


FIGURE 8. Comparison of New Brunswick and Saskatchewan potash deposits.

was the first of two potash mines currently operating in New Brunswick. In addition to the mine and concentrating facility, the company operates a potash shipping terminal at Saint John, less than 80 km to the southwest.

PCA signed a mining lease with the Province in June of 1978 that covers an area of 19 187 ha. The lease agreement is for a term of 21 years with renewal options for three successive 21-year periods. The terms of the lease stipulate that a royalty of 6 1/4% of the sales price of standard-grade product (f.o.b. mine site) is payable to the Province.

Initial development began in 1978 with the construction of the first of two 610 m shafts. This initial phase was completed by late

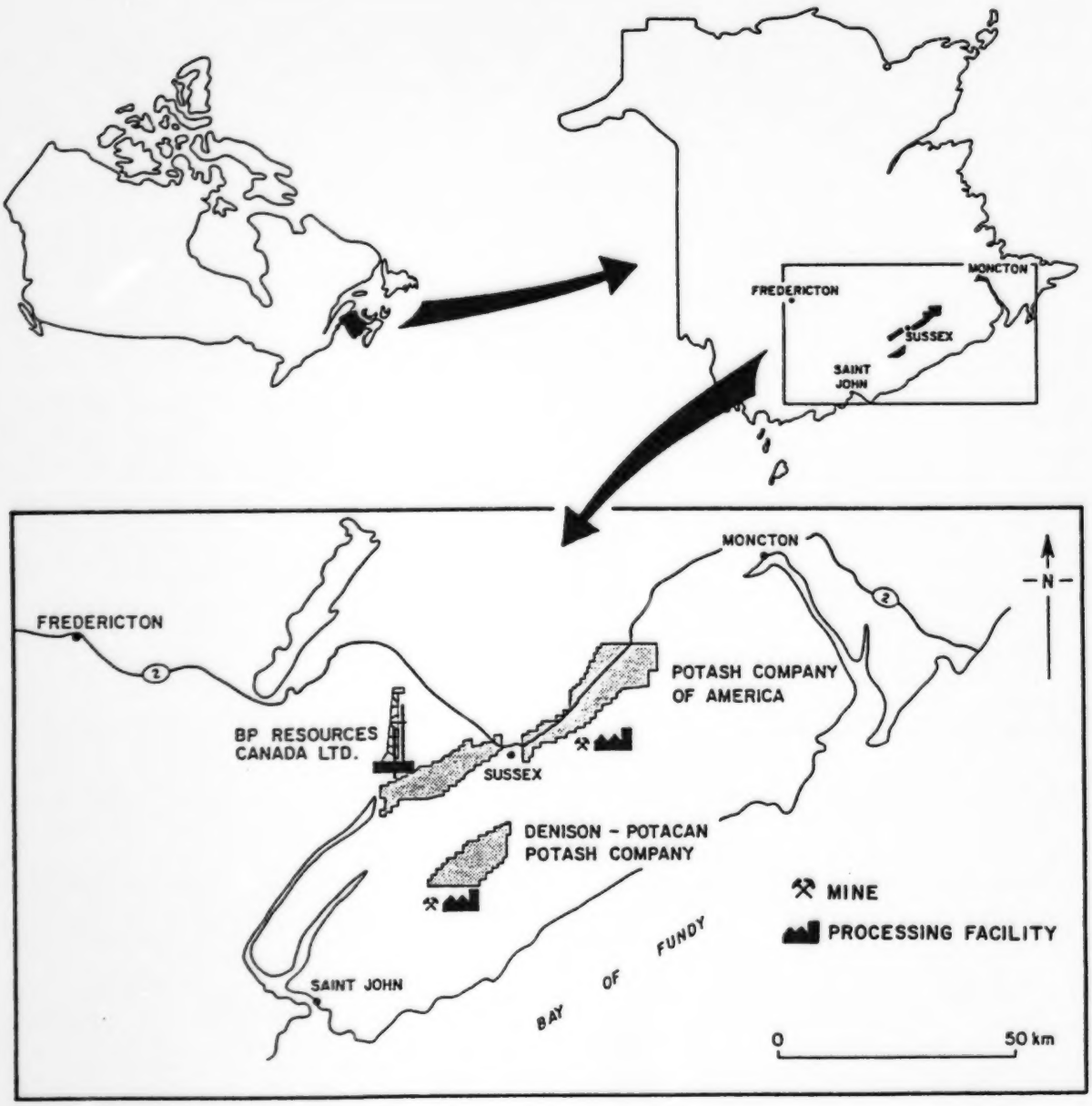


FIGURE 9. Potash mining leases in New Brunswick.

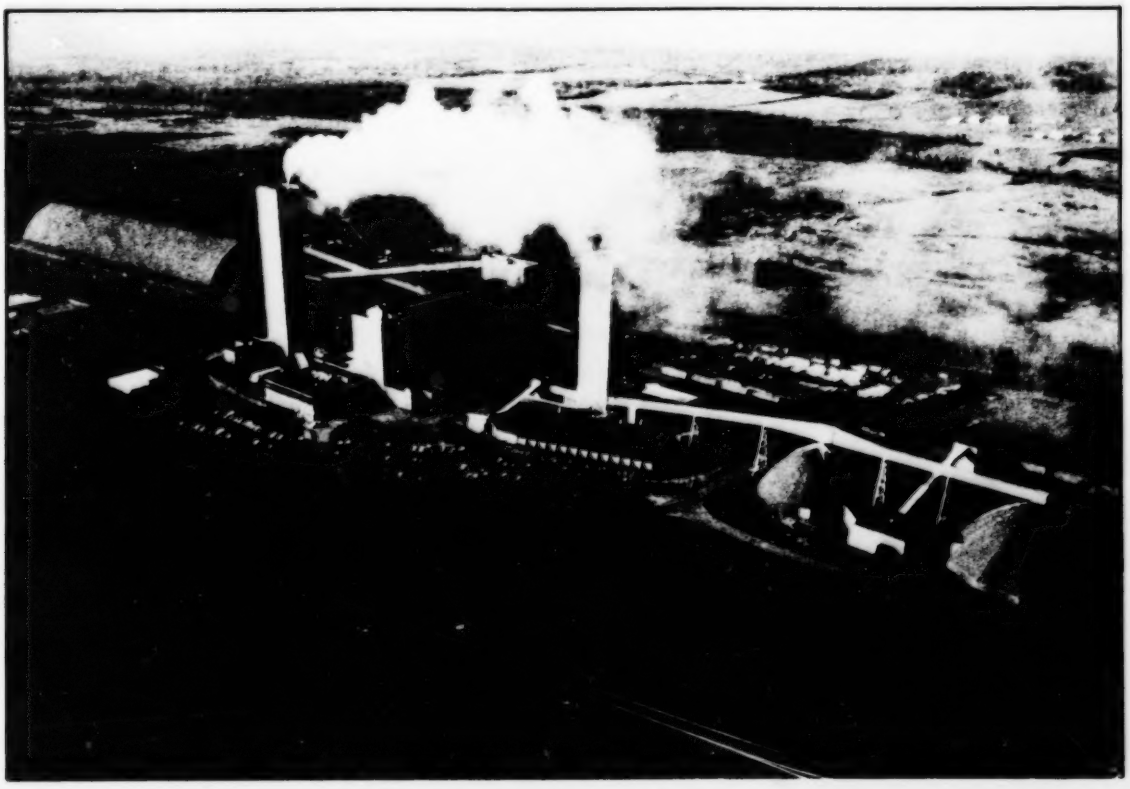


FIGURE 10. The Potash Company of America, Inc. mine and concentrating facility, 5 km east of Sussex, New Brunswick.

1983. At the peak of mine and mill construction (1982-83), the workforce of 720 people consisted largely of contract employees. By 1987, this number has been reduced to an average permanent workforce at the mine and mill of about 330 people.

Mining is carried out by cut-and-fill procedures and by using continuous-mining machines. This method was adopted because of the configuration of the orebody and the requirement of disposing of tailings underground to comply with environmental regulations.

After the ore is brought to the surface, it is processed utilizing advanced technology and equipment. The mill produces two grades of potash: standard and granular. High-grade salt adjacent to the potash orebody is also mined and sold as a by-product in order to accommodate the storage of surplus tailings. Chemical- and road-grade salt is marketed under a sales agreement with International Salt Co. through its Canadian subsidiary, Iroquois Salt Products Ltd. The company now sells more than 500 000 t of industrial-grade salt each year.

Potash from the processing facility is stored in covered warehouses at the mine site and at the Port of Saint John (Figure 11). The combined storage capacity is more than 200 000 t.

During the start-up phase, initial production was at a level considerably below the mine's rated

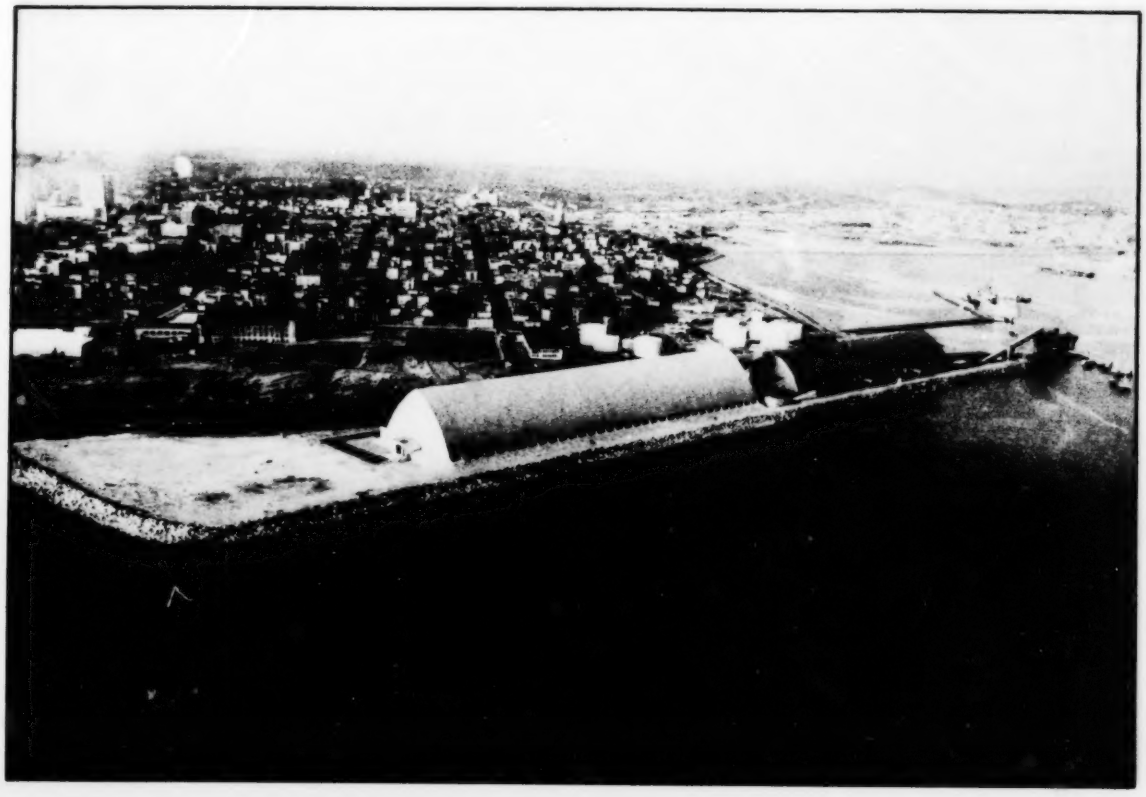


FIGURE 11. Potash ship-loading terminal at the Port of Saint John, New Brunswick.

capacity of 380 000 tpa K_2O equivalent (635 000 product tonnes). In 1984, the level of production had reached only 40% of design capacity.

In January 1986, Rio Algom Limited of Toronto had agreed to purchase PCA from its parent company, Ideal Basic Industries Inc. of Denver, Colorado. The new owner, committed to increasing production, has invested about $30 000 000 in additional capital expenditures. With this added investment, the operation is improving its production levels and should be capable of expanding to a capacity of 548 000 tpa K_2O by the early 1990s, placing it in a good position to take advantage of forecasted improvements in world market conditions.

Preliminary figures for 1987 indicate a 30% increase in production over that for 1986. Major shipments were made to Western Europe, Latin America and Asia.

DENISON-POTACAN POTASH COMPANY

In 1979, Denison Mines Ltd. was assigned the rights to the 8 887 ha mining lease covering the Clover Hill property, which had been purchased from International Minerals and Chemical Corporation. Terms of the mining lease were essentially the same as the PCA lease agreement (6 1/4% royalty based on the selling price of standard-grade product).

Denison-Potacan Potash Company is a joint enterprise, in which Denison Mines Ltd. (60% interest) is Manager of Operations and Potash Company of Canada (Potacan) (40% interest) is Manager of Marketing.

Potacan is owned equally by West German and French interests.

Denison-Potacan commenced production at its Clover Hill mine site in July, 1985, after nearly six and one-half years of shaft sinking, exploration and construction (Figure 12).

The mine should be capable of producing close to its rated capacity of about 780 000 t K_2O (1 300 000 product tonnes) in 1988.

Modified room-and-pillar mining methods that employ both continuous mining and, to a lesser extent, drill and blast techniques are used to extract ore from zones 2 to 23 m thick, and 850 m below surface.

A research project concerning utilization of tailings as mine back-fill commenced in 1986 under a Canada-New Brunswick Mineral Development Agreement and in cooperation with Denison-Potacan. This work, together with a comprehensive rock mechanics programme, should enable the effective emplacement of salt tailings underground, increase potash extraction rates, and eliminate potential environmental problems resulting from long-term salt storage at surface.

The mill produces four product grades: standard, coarse, granular and fine. A central computerized control system is utilized to monitor all facets of mill operation.

Prior to the adoption of an efficient underground backfilling programme, tailings are being stored in an 80 ha tailings area and brine pond. Thick polyethylene liners are used to contain the tailings and brine. Excess brine from the refining process is pumped via a pipeline to a discharge site on the Bay of Fundy coast, 34 km south of the mine.

An on-site facility is capable of storing up to 90 000 t of product. Potash is transported from the mine site via a 20 km spur line (Figure 13) that links the property to the main Moncton-Saint John railway line to the west. At the Port of Saint John, a 115 000 t storage building has been erected. The rail-unloading and ship-loading facilities are shared with PCA. Ship-loading facilities are designed to handle shipments up to 35 000 t. In 1987, shipments were made to customers in North and South America and Asia.

In 1987, the workforce at Denison-Potacan numbered about 582 people; about 25% was contract employees.

BP RESOURCES CANADA LTD. (SELCO DIVISION) In February, 1981, BP was awarded the potash exploration rights for an area of 10 125 ha near Lower Millstream, 10 km west of Sussex (Figure 9). The three-year exploration agreement called for drilling three holes, minimum expenditure of $750 000, commitment to the 6 1/4% potash royalty, and 21.1% share of net cash profit after earning a 15% return on investment. A one-year extension to the exploration agreement was granted in January, 1984, to enable completion of the programme.

Eleven exploration drill holes, one shaft pilot hole and several detailed geophysical studies have been completed to date on this property. Numerous zones of potash mineralization have been encountered between 950 and 1051 m below surface. Preliminary tonnage and grade estimates on at least two zones are very encouraging.

BP prepared a preliminary feasibility study and signed a mining lease in July, 1985. To date, the company has made no decision on sinking an exploration shaft and conducting an underground exploration programme. BP is actively searching for a partner, preferably

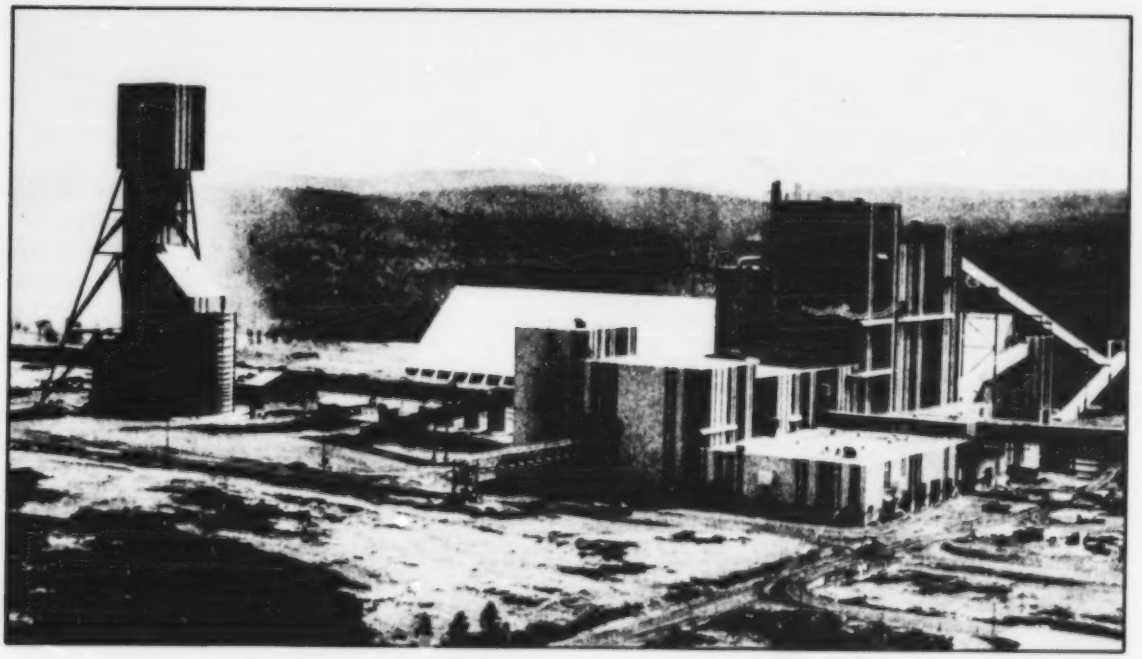


FIGURE 12. The Denison-Potacan Potash Company mine, 20 km south of Sussex, New Brunswick.

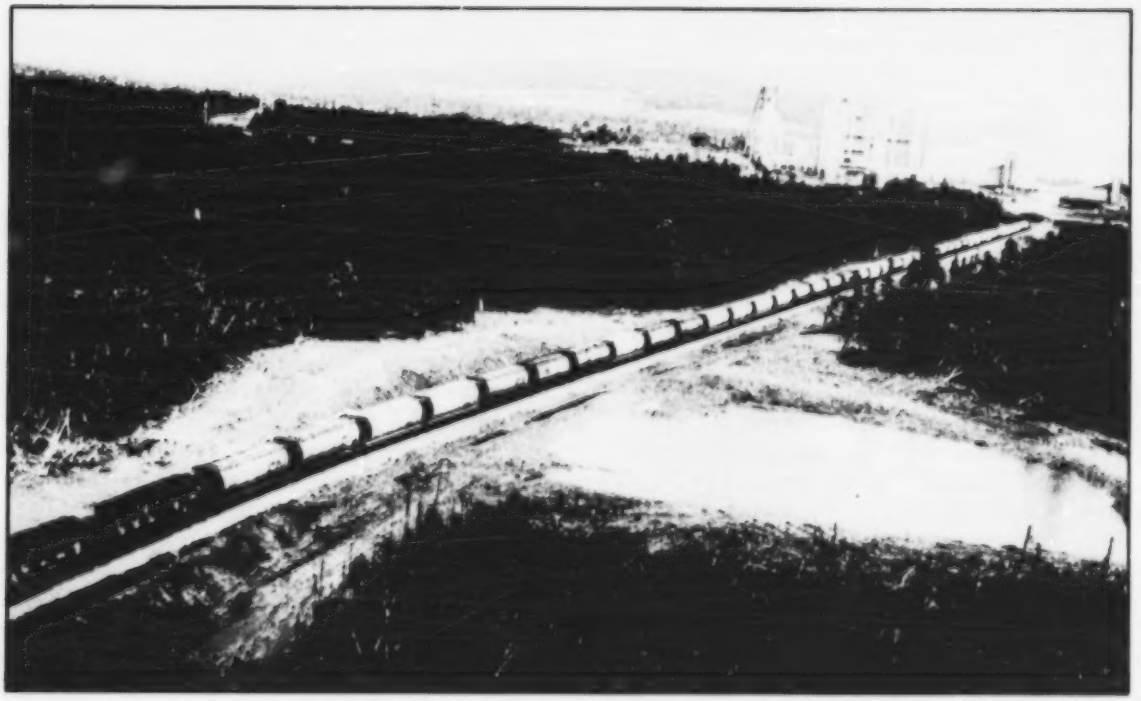


FIGURE 13. Railway line linking Denison-Potacan with the Port of Saint John, less than 60 km away.

one with marketing experience, to take equity in the project.

A clause in the mining lease requires that the company produce potash by July, 1993, at a minimum level of 500 000 t. Based upon the experiences of the two New Brunswick producers, this date will be difficult to achieve unless a decision to sink the shaft is made in 1988.

New Brunswick Potash - Advantages and Opportunities

At present, New Brunswick's potash production capacity, about 1 170 000 t K_2O, relates to a 10% share of total installed Canadian production capability.

The level of capital investment in the potash industry has been, and should continue to be, significant. Combined public and private sector expenditures since the early 1970s of just under $600 000 000 have been a valued stimulus to the Province's economy. It was important during the recessionary period of the early 1980s when more than 70% of this amount was disbursed. During the peak construction phase, potash development can be translated collectively into more than 1000 well-paid jobs. In the present post-construction period, average employment levels at the two existing mines have been steadily maintained at approximately 800 people.

Future potash-related development in New Brunswick and throughout the world is directly proportional to "growth" within the agricultural sector. The prospect of cutbacks in agricultural production in key farming areas of North America and Western Europe pose a real threat to potash marketing. Depressed crop prices and the indebtedness of North American farmers suggest that North American potash producers will have to rely more on offshore exports if they are to maintain or increase sales volumes.

Over the past few years, the North American potash industry has suffered from high inventories, soft market conditions, and low prices although there have been signs of price improvements recently. Despite this apparently gloomy situation, New Brunswick producers and would-be producers can look optimistically to the future because of the proximity (less than 70 km) to the all-weather Port of Saint John, and a good road and rail infrastructure. This should give the Province's producers a substantial competitive edge in certain market areas traditionally supplied by others.

A favourable geographic location places New Brunswick in a particularly strong position for significant market penetration of the eastern seaboard of the United States and other offshore destinations. In 1987, potash was exported from the Port of Saint John to Brazil, Western Europe, Asia, Oceania, the United States, and other destinations.

Under certain conditions, it may be cost-effective to move New Brunswick potash into the Great Lakes region - the potash gateway to the American Midwest. The substantially lower ocean freight rates allow New Brunswick potash to be delivered for extremely competitive prices.

In addition, various potash mines throughout the world are faced with depleting reserves, increased production costs, an overall reduction in production capacity, or other production problems. New Brunswick producers should be able to fill any shortfalls that may develop in existing North American and offshore markets.

Most market observers appear to agree that potash prices have bottomed out and world demand will in-

crease annually at an average of 1.5-3.5% until the year 2000. At this rate, it has been postulated that installed and planned Canadian production capacity could be completely utilized by the early to mid-1990s. Any additional expansion would benefit the Province's economy.

Current weak market conditions have, no doubt, played a significant part in delaying the decision by BP Resources Canada Ltd. on whether to proceed with further evaluation of their Lower Millstream property - a decision that could result in additional capital expenditures between $350 000 000 and $450 000 000 and that could expand the Province's production capacity to 1 700 000 tpa K_2O by 1996-97.

If market demand expands as predicted, there could be a renewal of interest in grass roots exploration for potash in the Province.

In the extreme southeastern part of the Province, the area between Dorchester and Tantramar (Figure 14) is a potential potash exploration area. Although subsurface, high-

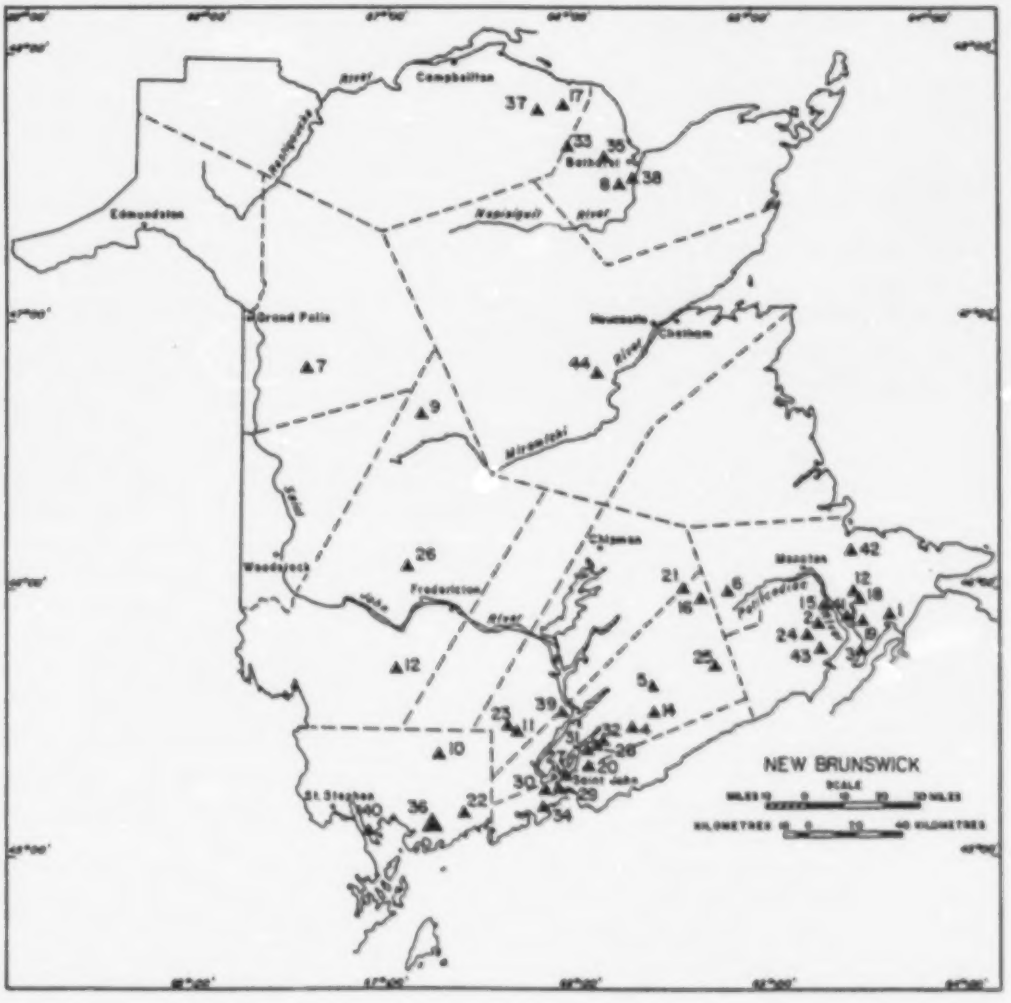


FIGURE 14. Selected industrial mineral occurrences in New Brunswick.

order, Windsor evaporites occur in the region and trace amounts of potash have been verified at a nearby Nova Scotia salt mine, the presence of significant potash mineralization cannot be determined because of the limited amount of geologic information available. However, some of the indicators for a potential deposit are clearly present.

The Province of New Brunswick remains committed to orderly development of its potash resources and its involvement in research studies in potash mineralogy, rock mechanics, tailings back-fill, and downstream processing in the years ahead. This research will provide a better understanding of New Brunswick potash deposits and thereby aid existing producers and potential producers in discovery, mining and extraction technologies.

SILICA

Various types of silica (quartz) deposits are known throughout the Province, including quartzites of

LEGEND (figure 14)

SALT/POTASH:
(1) Dorchester-Tantramar
GYPSUM
(2) Hillsborough
(3) Cape Maringouin
(4) Upham
(5) Fox Hill
(6) Intervale
(7) Plaster Rock
FLUORITE:
(8) Pabineau Lake
(9) Burnt Hill
(10) Mount Pleasant
(11) Square Lake
(12) Memramcook East
(13) Harvey Station
(14) Hammondvale - Upham
GLAUBERITE
(15) Weldon-Gautreau
(16) Cornhill East
BARITE
(17) Mitchell Settlement
(18) Memramcook East
(19) Taylor Village
GRAPHITE
(20) Golden Grove
(21) Thorne Brook
DIATOMITE
(22) Triconia Lake
(23) Square Lake
(24) Stanyard Lake
(25) Mechanic Lake
BERYL
(26) Zealand Station
LIMESTONE
(27) Torryburn
(28) French Village
(29) Green Head Island
(30) Ketepec
(31) Elliott Road
(32) Nauwigewauk
(33) Sormany
DOLOMITE
(34) Lorneville
(35) Armstrong Brook
GRANITE
(36) St. George/Dawson Mountain/ Digedeguash Lake
(37) Antinouri Lake
(38) Bathurst
(39) Hampstead
(40) Bald Hill
SANDSTONE
(41) Beaumont
(42) Shediac
(43) Curryville
(44) Quarryville

Precambrian age, quartzose sandstones of Pennsylvanian age, vein quartz, and quartz sands.

CHALEUR SILICA LIMITED This deposit, located 6.5 km east of Bathurst (Figure 3), consists of a flat-lying, quartz-rich sandstone of Pennsylvanian age. The siliceous strata at this locality was first recognized in the early 1960s, but production did not commenced until 1976. The operation is seasonal and has produced up to 60 000 t annually. Most of the product is utilized as flux at the Belledune smelter of Brunswick Mining and Smelting Corporation Limited, 40 km to the north (Figure 3). The company is involved with developing new markets, which have included sandblast sand, additives to nursery soils, and low-alkali cements. Reserves are estimated to be several hundred thousand tonnes averaging 95% SiO_2.

SUSSEX SILICA INC. The Sussex Silica Inc. deposit (Figure 15), located about 16 km south of Sussex (Figure 3), consists of high-grade, quartz-rich, silica sand. The property was brought into production in 1986 following its initial discovery in 1981. Current production capacity of the operation is estimated to be 80 000 tpa. Indicated reserves are estimated to be several million tonnes grading in excess of 98% SiO_2.

Initial production from this mine has consisted of lump silica (pebbles) and sand of various sizes. The lump silica and coarse-grained sand are used in the manufacture of silicon metal and silicon carbide in Quebec. Attempts are being made to market finer grained material as tree nursery and decorative sand, and as an ingredient in the manufacture of glass and fiberglass insulation.

Extremely fine sand containing significant amounts of kaolinitic clay is a by-product of the refining and sizing process. This material is currently stockpiled at the plant site.

SULPHUR

Sulphur is recovered in the form of sulphuric acid at the Belledune smelter of Brunswick Mining and Smelting Corporation Limited (Figure 3). Sulphur is also recovered from imported crude petroleum at the Irving Oil Limited refinery at Saint John.

BRUNSWICK MINING AND SMELTING CORPORATION LIMITED (FERTILIZER AND SMELTING DIVISION) The Belledune smelter (Figure 16), located 30 km northwest of Bathurst, processes lead concentrate produced at the company's mine 40 km to the south. Accumulated sulphur from the smelting process is collected in the form of SO_2 stack-gas emissions and is converted to sulphuric acid. Most of the 90 000 t of sulphur produced annually is purchased by an adjacent fertilizer plant (Figure 17), where the acid is combined with phosphate rock from Florida and ammonia to produce diammonium phosphate, a basic fertilizer ingredient. The annual production from this plant is approximately 150 0000 tpa.

GYPSUM

Gypsum was one of the first mineral commodities to be mined in New Brunswick. Quarries in the Hillsborough area were in operation as early as 1840. A few other small deposits were known in the Province, but they operated only on an intermittent basis during the latter part of the 19th century.

The gypsum-anhydrite deposits

Figure 15. The Sussex Silica Inc. property, 16 km south of Sussex, New Brunswick.

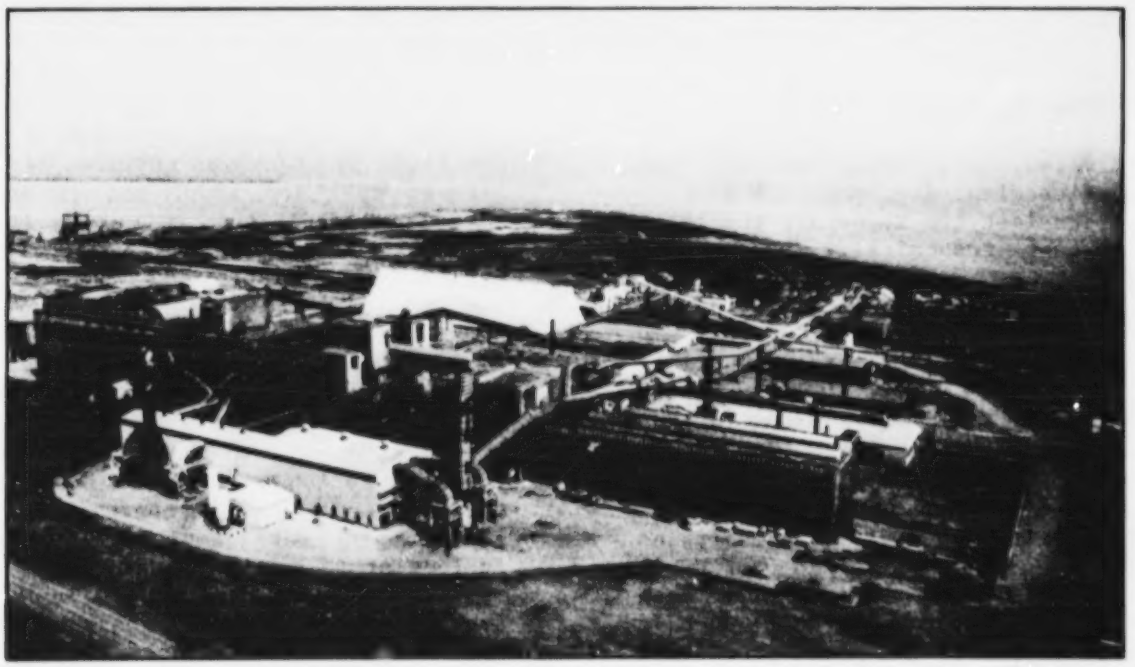


Figure 16. Brunswick Mining and Smelting Corporation Limited smelter at Belledune, New Brunswick.

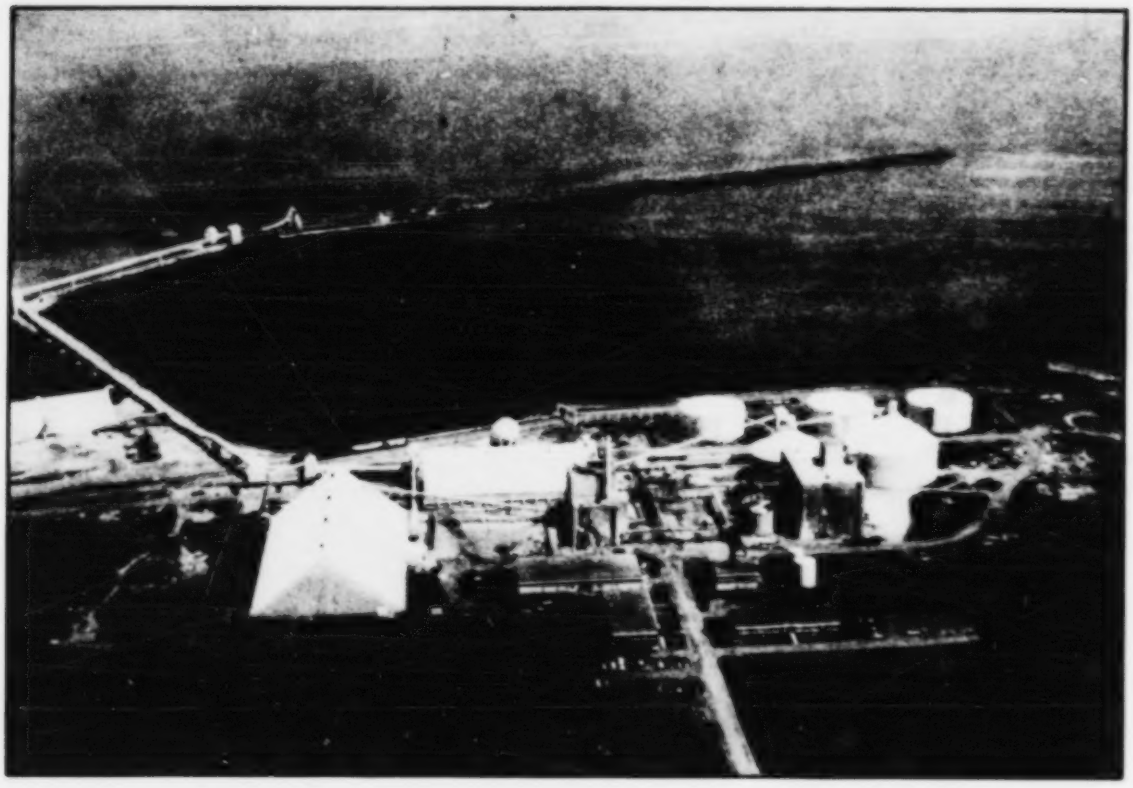


Figure 17. Brunswick Mining and Smelting Corporation Limited fertilizer plant at Belledune, New Brunswick.

of New Brunswick fall into four main categories: (1) massive, (2) laminated, (3) nodule-bearing, and (4) disseminated.

The last two types are the least important economically because of impurities, which include variable quantities of carbonate, silica, and argillaceous materials.

The deposits of massive and laminated gypsum, located 20 km south of Moncton and 5 km west of the Petitcodiac River near Hillsborough, are probably the most significant in the Province (Figure 14). The gypsum, part of the Mississippian Windsor Group, occurs in two small fault-bound basins. The beds are gently dipping and as much as 20 m thick in places. Annual production prior to the turn of the century was in the order of 100 000 t.

The Hillsborough deposits were acquired by Canadian Gypsum Ltd. between 1927 and 1930, and at one time provided raw material for Atlantic Canada's only wallboard manufacturing plant located in the village of Hillsborough. The company produced 40 000 to 50 000 t of gypsum annually. Despite attempts to improve the plant facility, competition from larger and more modern plants in Québec forced Canadian Gypsum Ltd. to cease operations in 1982. Approximately 150 people were employed during periods of peak production.

Other gypsum occurrences in New Brunswick also belong to strata of the Windsor Group. Those deposits that have produced a limited amount

of gypsum include Cape Maringouin, Fox Hill and Upham (Figure 14). At Intervale, Lafarge Canada Inc. has quarried as much as 20 000 t of gypsum annually for use as a retarder in cement production. At Plaster Rock in northwestern New Brunswick, unsuccessful attempts have been made to mine gypsiferous siltstones and shales for use as a soil additive for agricultural purposes.

FLUORITE

More than 35 fluorite occurrences are known throughout the Province. These can be classified into four major categories:

(1) Fluorite associated with granites and related intrusive rocks. It is a common constituent of many tungsten, molybdenum and tin occurrences (e.g., Pabineau Lake, Burnt Hill, Mount Pleasant and Square Lake (Figure 14). At the Mount Pleasant tungsten deposit, fluorite constitutes about 5% of the ore. A few kilometres to the south, a fluorite-cemented breccia several metres wide has been discovered.

(2) Fluorite associated with volcanic flows and tuffs. Solidification of a rock melt results in the concentration of a variety of elements including fluorine in the residual fluid phase. Fluorite is concentrated by fractionation and later may be localized by deformation (faulting) or differences in pressure or temperature (e.g., Mount Pleasant, Memramcook East, Harvey Station; Figure 14).

Fluorite commonly occurs along fractures or near shear zones through fluorite-bearing rhyolites, tuffs and agglomerates. In some cases, it has been dissolved or leached out of the host rocks and redeposited in fractures (e.g., Manners Sutton; Figure 14). These deposits generally occur as small fissure veins, in-fillings of vesicles, or as a matrix in zones of brecciation.

(3) Fluorite as replacement deposits in limestones. These deposits, which originated from circulating fluorine-rich solutions, are typically irregular in shape and commonly contain numerous small vesicles partly filled with crystalline fluorite (e.g., Hammondvale-Upham area; Figure 14).

(4) Contact metamorphism and metasomatism. The hydrothermal emplacement of fluorite into host rocks near igneous sources appears to have been another method by which fluorite occurrences have formed in the Province.

GLAUBERITE

Glauberite, an anhydrous sodium-calcium sulphate ($Na_2SO_4.CaSO_4$), is found near Weldon-Gautreau and at Cornhill East in southeastern New Brunswick (Figure 14). It is associated with rock salt, anhydrite, and shale at depths of 425-500 m. The unusual composition of these evaporites indicates that they probably were deposited in a shallow, undrained lacustrine environment.

Exploratory drilling in the Weldon-Gautreau area in the early 1960s has revealed that rock salt and glauberite are restricted to a small structural sedimentary basin located immediately north of Hillsborough. The salt body contained in this basin forms an elliptical-concave lens with an areal extent of about 1300 ha. Past drilling has indicated in situ reserves that exceed 25 000 000 t of glauberite with an average grade of 23% Na_2SO_4. There is an excellent possibility that additional reserves could be outlined.

Drilling in the Cornhill area also intersected rock salt and minor glauberite at a depth of 785-940 m. The average grade is 10% Na_2SO_4, but there are few indications of the extent of this deposit.

BARITE

Barite has been found at a number of localities throughout New Brunswick (Figure 14) but it has never been produced in commercial quantities. A vein of barite has been reported near Mitchell Settlement in the northern part of the Province, and small quantities have been identified in base metal ores of the Bathurst-Newcastle area. One of the best known barite occurrences in the Province is at Memramcook East (Figure 14) where barite is found associated with quartz, calcite, and minor base metals in a north-striking fault zone within Carboniferous strata. A few kilometres to the south at Taylor Village, a large, east-northeast-striking fault zone containing both celestite and barite has been outlined. This zone, up to 25 m wide, has been traced laterally for about 1000 m.

MARL

A white marl occurs in an unnamed lake near Upper Kent, 25 km north of Florenceville in western New Brunswick (Figure 3). This lake has been partially drained and the marl dredged from its bottom is spread in a thin layer and air dried. Small quantities are distributed locally, mainly for agricultural purposes. The deposit, which averages more than 95% $CaCO_3$, is currently worked by Upper Kent Lime Works Ltd. Annual production is reported to be between 1000 and 1500 t of marl. The potential for other similar deposits in western New Brunswick is considered good.

GRAPHITE

Graphite was mined in the City of Saint John in the 1840s. Deposits consist of highly sheared carbonaceous material within Precambrian limestone and related sedimentary rocks.

One of the better known occurrences is at Golden Grove (Figure 14), approximately 25 km northeast of the city. Graphite was discovered at this location more than 50 years ago. In the 1930s, numerous investigative pits were excavated but the deposit received only cursory attention until the 1980s. Recent geological and geophysical studies carried out by Glenvet Resources Ltd. have been relatively successful in further defining the extent of the occurrence. Trenching has indicated a graphite horizon 2 m in width and 425 m in strike length, that contains zones of high-grade (30-38%) carbon. Possible reserves, based on the continuity of the material projected to depths of 150-300 m, are estimated to be 225 000 to 450 000 t; however, this must be confirmed by drilling.

Preliminary mineralogical and metallurgical test work appears to indicate some potential for the Golden Grove deposit as a source of flake graphite.

Highly carbonaceous strata containing graphitic shear zones are also known at Thorne Brook, 5 km north of Havelock in Kings County (Figure 14).

DIATOMITE

Diatomite occurrences are restricted to the southern part of New Brunswick where they occur in lake bottoms (e.g., Mechanic Lake,

Triconia Lake, Square Lake, and Stanyard Lake; Figure 14). A small amount of diatomite was produced many years ago from Mechanic Lake, southeast of Sussex.

BERYL

An occurrence of beryl is located near Zealand Station, approximately 40 km northwest of Fredericton (Figure 14). This beryllium occurrence has been investigated periodically over the last 30 years. Stripping and trenching, detailed mapping and sampling, and related geochemical and geophysical surveys have been carried out recently by Shediac Bay Resources Inc. Possible ore reserves estimated at 147 000 t of ore grading 0.74% BeO require confirmation through a drilling programme.

LIMESTONE AND DOLOMITE

History

Limestone has been known to occur in New Brunswick for more than 350 years. In the 17th century, Champlain, one of the first explorers in the New World, described the limestone exposures in cliffs in the area that is now Saint John. These limestones were probably one of the first minerals mined in this Province.

Early settlers to the Province quickly recognized the agricultural and construction attributes of limestone and used the resource to supply their local needs. Early lime kilns, the remains of which are still visible at many locations, generally consisted of small, wood-fired, shaft-type structures built using heat-resistant field stone. They rarely were more than 3 m high, and seldom covering an area exceeding 3 m^2. The kilns were often located on steep hillsides to facilitate charging.

These primitive operations were gradually supplanted by larger kilns as the limestone industry in the Saint John area expanded during the mid-1800s. By 1890, as many as 25 lime-burning units were in operation in the area. A thriving export trade was carried on with the United States.

By the 1930s, the New Brunswick limestone industry had developed most of its present day characteristics, consisting of eight active quarries, four operating lime kilns and one hydrated lime plant. Although Saint John continued to be the centre of the industry, small operations began to spring up in the Bathurst and Moncton areas.

In 1952, the Canada Cement Company Limited began production at Havelock (Lafarge Canada Inc.; Figure 3), the location of the first cement plant in the Maritime Provinces.

Geology and Distribution

Limestone is represented to some extent in most geologic systems in New Brunswick, but is economically important only in the Carboniferous, Silurian-Ordovician, and Precambrian systems (Figure 18). In addition to these "hard rock" deposits, calcareous marls believed to be of Quaternary age are scattered throughout the western and northwestern parts of the Province.

The limestone of each system has a number of distinguishing characteristics.

The oldest limestones and dolomites are contained in Precambrian strata (oldest in New Brunswick) found in and about the City of Saint John. These rocks are intimately associated with varying amounts of quartzite and argillite. They are generally light grey, colour-banded,

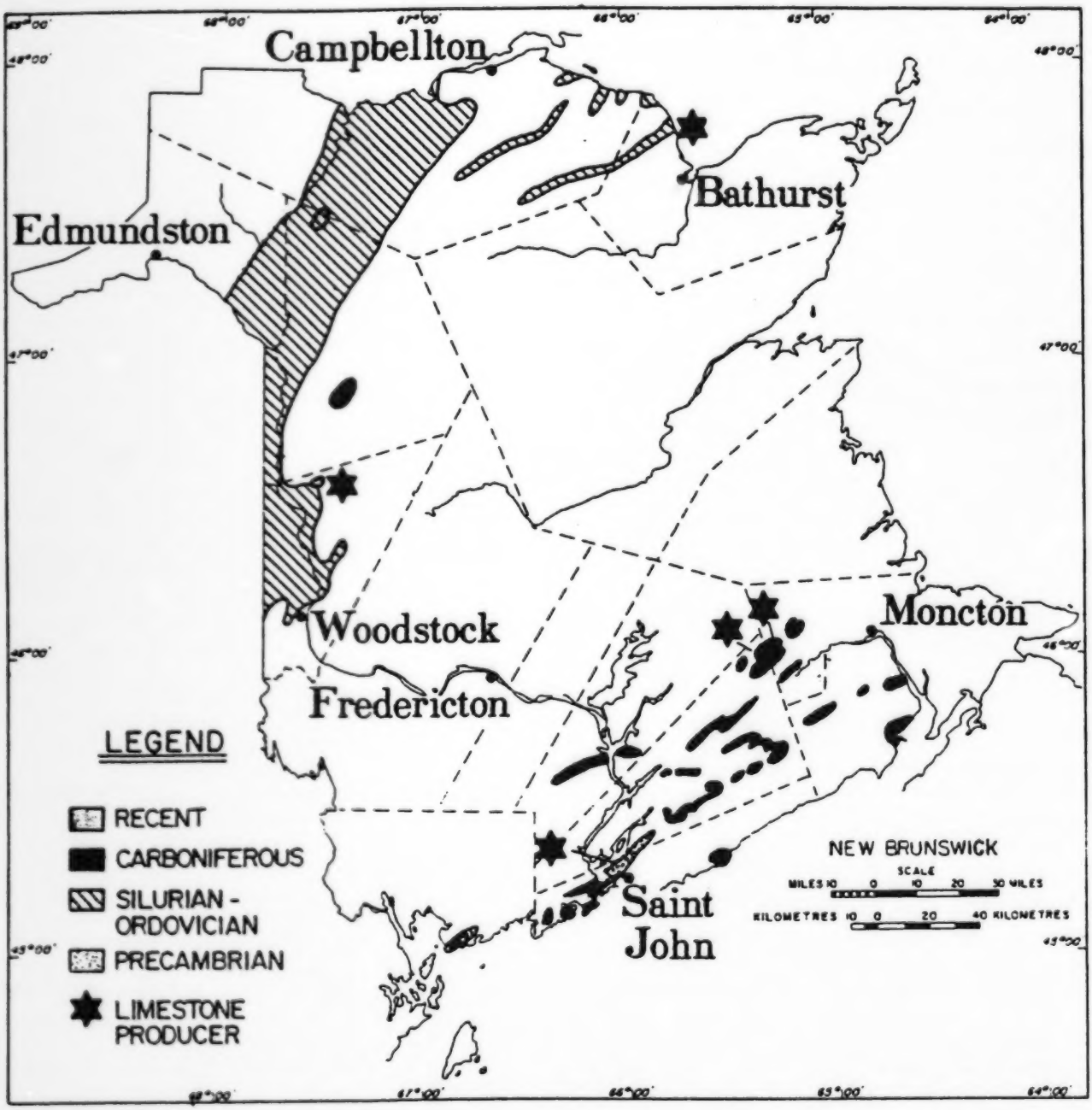


FIGURE 18. General distribution of limestone-bearing rocks in New Brunswick.

medium- to coarse-grained and massive. They have been subjected to numerous deformational events characterized by many faults and complex fold patterns. Intersecting diabase dykes are common throughout the limestone/dolomite sequence.

Ordovician-Silurian limestones, found mainly in northern and western New Brunswick, can be divided into two distinct lithologic assemblages. The first occurs discontinuously along the south shore of Chaleur Bay from Campbellton to just west of Bathurst. These rocks are largely represented by arenaceous to argillaceous, nodular limestones that are often intercalated with shale. Large, isolated blocks of exceptionally high grade, recrystallized, reefal limestone are scattered throughout the region. The second major lithotype, underlying an extensive area of western and northwestern New Brunswick, form a repetitive sequence of argillaceous limestone, limestone, and calcareous argillite.

Most Ordovician-Silurian limestones and argillaceous limestones are typically associated with shale or its metamorphosed equivalent. These rocks are commonly tightly folded, forming doubly plunging anticlines and synclines. The steeply dipping beds often exhibit a fairly well defined cleavage. Dykes and quartz veins are uncommon.

Carboniferous limestones are associated with the Lower Mississippian Windsor Group rocks in southern New Brunswick and with the relatively isolated Plaster Rock Formation and Bonaventure Formation strata in west-central and northern New Brunswick, respectively. Carboniferous limestones vary from red-grey to dark olive-grey. They are generally fine-grained and occur in nodular to massive beds. Cross-cutting quartz veins and dykes are absent. Local recrystallization is not attributed to widespread deformation. The rocks are generally folded into broad, open folds with amplitudes of several kilometres and dips rarely exceeding 45°.

Although limestone from all three geologic systems cannot be decisively distinguished on the basis of their chemistry, there are variations in the proportions of MgO and CaO. Carboniferous limestones are characterized by average CaO grades of 50-54% and are usually deficient in MgO. Similarly, Ordovician-Silurian limestones have low MgO values, but also have lower average CaO values (40-51%). High MgO values are particularly characteristic of limestones in the Saint John region, where associated dolomite and dolomitic limestone constitute a considerable proportion of the strata.

Reserves

Although limestone reserves appear more than adequate to meet future regional demands for most currently manufactured limestone products, it is becoming increasingly important to identify resources suitable for more quality-dependant and highly specialized uses. This is particularly important in light of the trend toward more stringent raw material specifications by consuming industries and increased land-use pressures from expanding urban communities.

The value of the resource depends upon its special chemical and physical properties and on its proximity to potential market areas.

A highly speculative estimate of total limestone reserves, based on reserves of limestone capable of being developed by current producers in the Province, would probably exceed 100 000 000 t. Whether or not these "reserves" are capable of meeting or exceeding future market specifications remains to be seen.

Development

In New Brunswick, the limestone industry consists of five producers. Together, these operations account for an annual production of 680 000 to 700 000 t, and contribute up to $10 000 000 annually to the Province's economy. In value of production, limestone ranks as the Province's sixth most important mineral commodity. However, because of its low unit cost, it contributes only 2-3% of the total value of mineral production. This proportion is not a true indicator of limestone's importance as a mineral commodity. It is probably one of the most versatile mineral commodities produced as it has a variety of uses in agriculture, construction, pollution control and the chemical industry.

BROOKVILLE MANUFACTURING COMPANY The company is a producer of agricultural dolomitic limestone, fertilizer filler, roofing granules, concrete and asphalt aggregate, driveway aggregate, road metal and hardpack road subbase at Brookville in East Saint John (Figure 19).

Production is dependent upon agricultural and construction activity in the Province. A decade ago, it reached 500 000 t, but over the past five years has been 200 000 to 225 000 t. The crushing and milling (pulverizing) capacities are approximately 250 and 90 t per hour, respectively. Reserves are sufficient for more than 10 years at the current production rate.

The Brookville area is underlain by steeply dipping limestones, dolomites, quartzites, and argillites of Precambrian age. The dolomite is suitable for agricultural purposes, averaging 56% $CaCO_3$, 40% $MgCO_3$, and 2% SiO_2. The company employs about 30 people during periods of peak production.

In addition to Brookville, a number of limestone quarries have operated in the past throughout the Saint John area. These quarries, located at Indiantown (Snowflake Lime), Torryburn, French Village and on the Green Head Peninsula (Figure 14), have all been abandoned.

At Ketepec in West Saint John (Figure 14), exploration has delineated several million tonnes of cement-grade limestone. High-grade dolomite and limestone are also known at Lorneville, Elliott Road, and Nauwigewauk (Figure 14).

HAVELOCK LIME Havelock Lime (a division of Dickenson Mines Ltd.), located at Havelock 40 km west of Moncton (Figures 3 and 20), is a producer of agricultural calcitic limestone, industrial and chemical process stone, and crushed stone for aggregate. It is Atlantic Canada's only producer of calcined and hydrated lime. Annual quarry output and crusher feed is usually within 10% of 300 000 t. Capacity for crushing is approximately 280 t per hour, for pulverizing is approximately 45 t per hour, and for calcining, capacity is 175-200 t per day. Although reserves accessible by conventional quarrying techniques at the company's Samphill quarry are limited, a long-term agreement that assures availability of large, high-quality reserves from a nearby quarry owned by Lafarge Canada Inc. was concluded early in 1986.

The company has recently embarked on an expansion programme designed to increase its lime production capacity by installing a Fuller annular-shaft kiln, the first of its kind in North America. The new lime kiln will have a capacity of 300 t of product per day after installation is complete in 1988.

LAFARGE CANADA INC. Lafarge Canada Inc., formerly Canada Cement Lafarge Ltd., has a quarry several kilometres east of Havelock

FIGURE 19. Brookville Manufacturing Company Ltd. quarry at Saint John, New Brunswick.

Figure 20. Havelock Lime (a Division of Dickenson Mines Ltd.) processing facility at Havelock, New Brunswick.

(Figures 3 and 21). The company has produced cement at this site since 1952, although the amount produced has steadily decreased since 1982.

The Havelock plant has not maintained its ability to operate profitably because of the following factors: (1) the recent decline in oil exploration (one of the main markets for Havelock specialty cement products); (2) protectionism against foreign cement imports in the United States; and (3) a significant reduction in the number of major construction projects in Atlantic Canada.

The plant has a reported clinker (cement) production capacity of 300 000 tpa and a grinding capacity of 315 000 t. Crushing capacity is 450 t per hour. A similar plant operated by the company at Brookfield, Nova Scotia, is a more modern and efficient operation. The combined capacity of the Havelock and Brookfield plants is about 800 000 t of cement per year. An estimate of current market capacity for Atlantic Canada cement products is less than 400 000 tpa.

Specialty cement products have traditionally been produced at Havelock because of the unique chemical properties of the limestone in the area.

Despite attempts by the company to maintain the Havelock plant as a grinding operation for imported Nova Scotia clinker, prevailing poor market conditions over the past few years have forced the company to further review the viability of the operation in 1987. As a result, the plant was closed indefinitely, and the property is only used as a distribution point for the Nova Scotia product.

The company, however, has actively maintained its quarry operations as part of contract obligations to supply Havelock Lime's plant with raw stone (up 300 000 tpa). Lafarge is also continuing to producte aggregate for its subsidiary, Permanent Concrete, Ltd.

Recent consideration concerning the possible construction of a "fixed-link crossing" between New Brunswick and Prince Edward Island could play a significant role in any decision to reopen the plant in the near future.

ELMTREE RESOURCES LTD. Elmtree Resources Ltd. operates a quarry and crushing-pulverizing plant about 20 km north of Bathurst near the village of Petit Rocher (Figures 3 and 22).

The Elmtree limestone deposit occurs within Silurian strata that underlie much of northern New Brunswick. Limestone horizons in the vicinity are lens-shaped and steeply dipping. Reserves are estimated at several hundred thousand tonnes, grading in excess of 95% $CaCO_3$.

Although good grade limestone has been known to occur in this area as early as 1880, continuous production was not achieved until 1930 when the Elmtree Co-op began to develop the deposit. It produced for 30 years at a rate of about 2900 tpa. In 1978, the property was acquired by Elmtree Resources Ltd. After detailed mapping and trenching, a crushing and screening plant and a large storage facility were erected. Annual production is in the order of 50 000 to 60 000 t, the bulk of the output of which is supplied to the lead smelter of Brunswick Mining and Smelting Corporation Limited at Belledune. Other products marketed include aggregate, fertilizer filler, and agricultural limestone. The operation employs about 15 people during periods of peak production.

Elmtree Resources Ltd. is currently examining a limestone

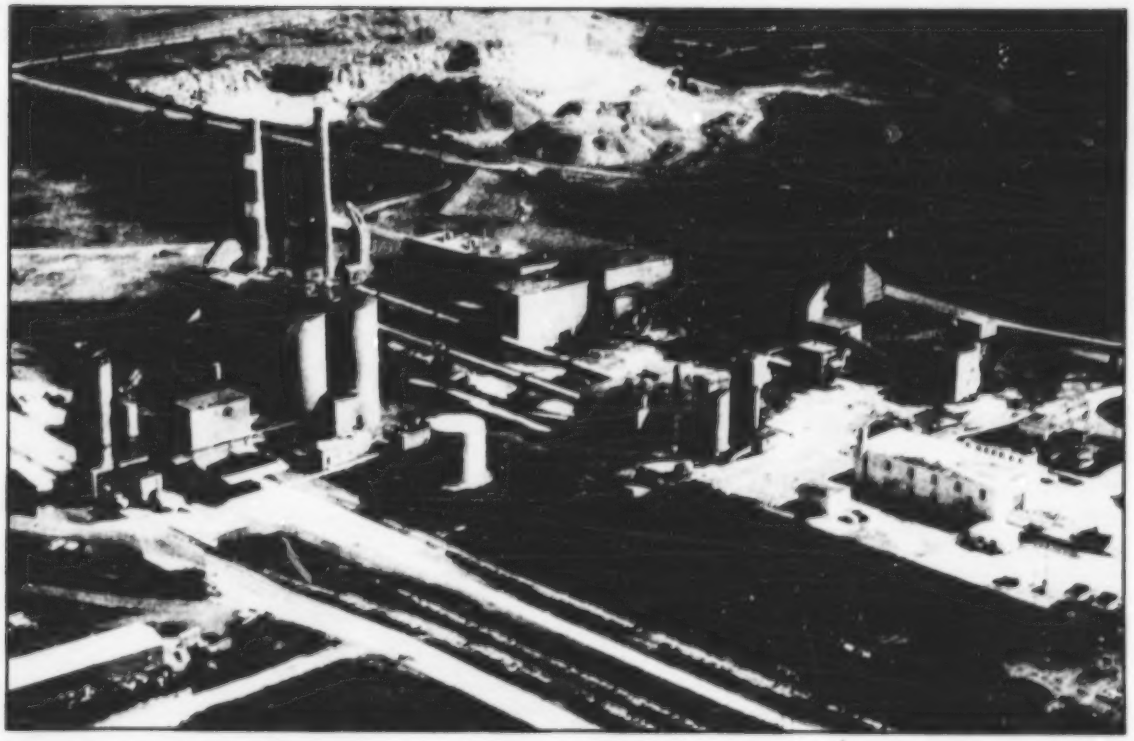


Figure 21. The Lafarge Canada Inc. cement plant, 3 km east of Havelock, New Brunswick.

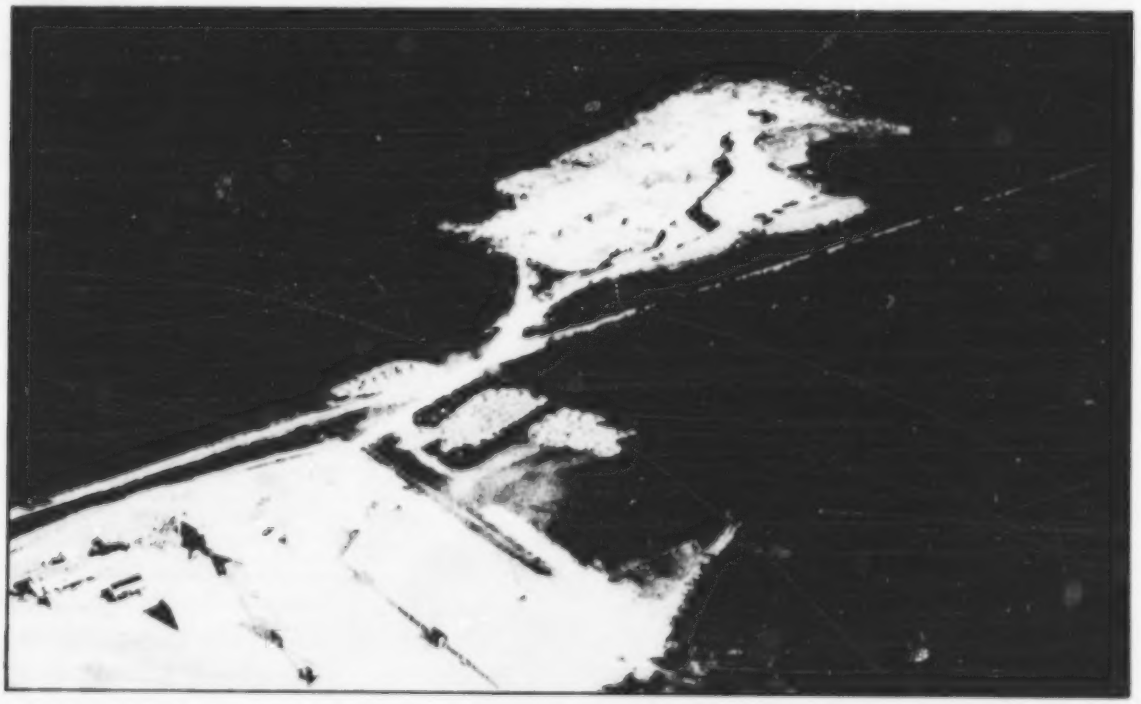


Figure 22. The Elmtree Resources Ltd. quarry, 20 km north of Bathurst, New Brunswick.

deposit 12 km west of Sormany (Figure 14), where several million tonnes of high-calcium Silurian limestone, grading 95% $CaCO_3$, occurs in two parallel bands, each a maximum of 120 m wide. The company has also opened up a deposit of dolomite at Armstrong Brook (Figure 14). Reserves are estimated at a few million tonnes, grading 57% $CaCO_3$ and 34% $MgCO_3$.

UPPER KENT LIME WORKS LTD. Upper Kent Lime Works Ltd. maintains production of marl, grading 95% $CaCO_3$, from the bottom of a small, partially drained lake at Maplehurst near Upper Kent in the northwestern part of the Province (Figure 3). Annual sales to the region's farmers are in the 1000 to 1500 t range.

PEAT

A peatland can be any bog, fen, swamp, or marsh that has a minimum accumulation of 30 cm of peat. Peat, the decomposed plant matter found in peatlands, has a high water-retaining capacity and low density.

Near the surface, peat is generally yellowish brown, fibrous, and only slightly decomposed (humified). With depth, the peat darkens and becomes more decomposed. The less humified peat is favoured by the horticultural industry, whereas the more humified peat is suitable as a source of fuel. In New Brunswick, only the less humified peat is harvested, principally for its horticultural qualities.

Peatlands occupy 2% (140 000 ha) of the Province's land surface and are located within a broad diagonal band that extends from the northeast to the southwest.

The mining of peat in New Brunswick took place as early as 1894[1] when it was used as animal litter. Large-scale commercial extraction of peat for horticultural use began in 1942 with the opening of peatlands near Shippagan in northeastern New Brunswick. Since then, production has grown steadily from a few carloads to approximately 7 000 000 bale equivalents (241 000 t) in 1987. The value of production for 1987 (more than $25 000 000) increased 8% over the 1986 value. With less than 1% of the nation's peatland area, New Brunswick is second only to the Province of Québec in terms of production. About 34% of the volume of Canadian shipments is produced in the Province. These figures demonstrate the vital role played by the peat moss industry in the New Brunswick economy.

Canada ranks fourth in the production of horticultural peat (after the USSR, the Federal Republic of West Germany, and the United States) with a total annual production of about 500 000 t. The combined peat resources of Canada and the USSR represent about 80% of the world peat resource. Although Canada accounts for about half of this total, the USSR is by far the largest producer of peat, with an annual production of about 300 000 000 t.

The peat harvesting season in New Brunswick usually extends from the middle of June to the middle of September. Peat is extracted mainly by vacuum harvesters using the milled peat method. Some producers also use a mechanized version of the early block-cutting method to pro-

---

[1] Ganong, W.F. 1897. Upon raised peat bogs in the Province of New Brunswick. Transactions of the Royal Society of Canada, 33, Section 4, v. 3, pp. 131-163.

duce a peat with higher fibre integrity. The weather during harvesting has an influence on production and product price because present mining methods depend heavily on warm, sunny days to lower the moisture content of the peat in the field. Rainy seasons will mean lower production levels. With a maximum of about 100 harvesting days available, periods of cool, wet weather greatly reduce the anticipated production levels.

The peat moss industry of New Brunswick is expanding healthily. In addition to 15 deposits in production (Figure 3), there are three at various stages of development and three under application. Of the 9000 ha being leased, 3000 ha (on 26 peatlands) are under production (Figure 23).

Companies can be divided into three groups:

(1) large producers with a minimum annual capacity of 800 000 bale equivalents (there are two);

(2) medium-sized producers with an annual capacity between 250 000 and 800 000 bale equivalents (there are six);

(3) small producers with a maximum annual capacity of 250 000 bale equivalents (there are seven).

Peat moss companies operating in New Brunswick represent a mosaic of ownerships, including locally owned family operations as well as those financed by Canadian and foreign investors, some of which are from the Province of Québec, the United States, the United Kingdom, and the Federal Republic of West Germany.

Peat moss is a low-unit-price commodity and the development of a peatland depends greatly on factors such as proximity to power lines, all-weather highways and markets. A rule of thumb used for estimating the capital investment necessary for initial production is $4.00 per bale equivalent, based on a planned production of 250 000 bale equivalents per year. This equates to an initial investment of at least $1 000 000.

The bulk of peat harvested is sold in bale form. Some companies also produce soil mixes by adding lime, fertilizers and other materials to the peat. Jiffy Products (N.B.) Ltd., a Norwegian company operating in Shippagan, manufactures pressed peat pots and pellets for the entire North American market.

Several factors contribute to the development potential of New Brunswick's peat resource:

(1) The quality of the resource. The Province possesses large and easily accessible deposits containing thick surficial layers of poorly humified sphagnum peat. Shrub content is generally low. There is sufficient high-quality peat to support a vigorous horticultural peat industry for many years.

(2) The availability of the resource. Most peatlands have good drainage possibilities and tree cover is generally sparse, particularly near the coast. In addition, expanding communities are not competing for the use of these lands, as may be the case with other industrial mineral developments.

(3) The year-round availability of port facilities at Saint John ensures lower transportation costs for distribution of peat products around the world. A peat bale selling for $3.00 f.o.b. plant site sells for $30.00 in Japan. In 1987, transportation-related costs exceeded $10 000 000.

(4) The proximity of the populous New England States.

(5) The availability of an able work force. The best peatlands occur in rural areas of northeastern New Brunswick. In this area, the peat industry is second only to the fishing industry in terms of pro-

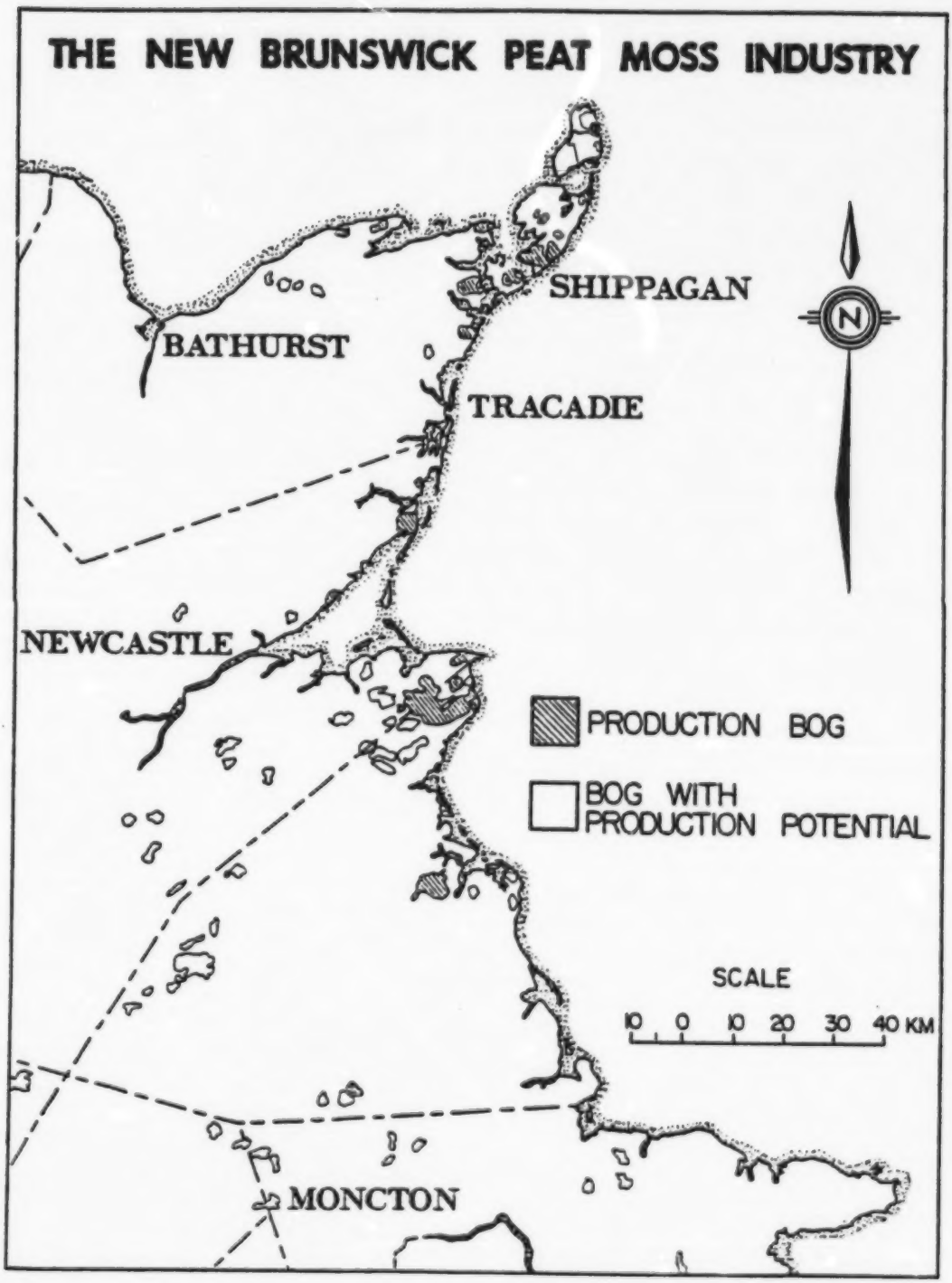


FIGURE 23. Distribution of peatlands in eastern New Brunswick that are leased or have development potential.

viding employment. In 1987, 850 workers were employed in the peat industry; however, 710 of these jobs were classified as seasonal positions. This translates into more than $5 000 000 in salaries, a significant contributing factor to the local economy of the region.

The future of the New Brunswick peat moss industry is linked to two main factors:

(1) The ability to deliver the product to its markets at a competitive price. This is largely beyond the control of the industry and is related principally to transportation costs and currency exchange rates.

(2) The ability to identify new uses for peat. Research into new uses for peat will become more important as new, lower cost substitutes for peat become available. The recently opened Peat Research and Development Centre (PRDC) in Shippagan is in a good position to assist the peat manufacturing sector by finding new uses for peat.

AGGREGATE RESOURCES

Aggregate resources, directly or indirectly, form the basis of much of our economic activity, whether it is in agriculture, forestry, manufacturing, or construction. Although sand and gravel have been produced and used since the days of early settlement, the economic significance attached to such materials has only recently been recognized.

The problems of population growth and dwindling sand and gravel resources are not as severe in New Brunswick as in some of the more populated and industrialized areas of Canada and the United States. Nevertheless, the Province is subject to similar pressures of land-use competition, decreasing reserves and inadequate quality. This is especially true in urban areas where heavy demands are being made on local aggregate resources. In Saint John, for example, nearly all of the readily available, high-quality sand and gravel deposits are being actively developed. Although the demand for aggregate increases steadily, producers will continue to move their operations farther from the city because of competition between their operations and urban growth, and because of public complaints regarding dust, noise, traffic, and safety associated with such extractive operations.

Other urban areas of New Brunswick share similar problems. Because aggregate resources are high volume, low-unit-value commodities, costs are destined to show marked increases in the years ahead.

During 1987, total aggregate production in New Brunswick (including clay, sand, gravel, and crushed stone) was slightly in excess of 12 000 000 t with a value in the order of $30 000 000. Of this, 9 600 000 t was from unconsolidated sources and 2 400 000 t was from bedrock sources.

Aggregate resources of New Brunswick frequently reflect the nature of the underlying bedrock. Because approximately 40 000 km^2 (50%) of the land mass consists of sandstone, shale, or slate, the probability of locating unconsolidated sources of good quality aggregate is seriously restricted. This is particularly true for the triangular area outlined by Bathurst in the north, Fredericton in the south, and Moncton in the east. The dominant rock types in this area are red and grey sandstones, conglomerates, and siltstones of Pennsylvanian age. The overlying gravels, which usually contain a

high proportion of these rock types, are difficult to beneficiate and at best provide aggregate of marginal quality.

Northwestern New Brunswick is underlain mainly by shales, limestones and sandstones of Devonian age, by calcareous and argillaceous sedimentary rock of Ordovician and/or Silurian age, and by greywackes, slates, siltstones, sandstones, conglomerates and limestones of Silurian age. None of these are suitable for good quality hard-rock aggregate because of the soft, friable nature of many of the clasts.

As a result, high-specification material for use as asphaltic and concrete aggregate must be transported considerable distances at an increased cost or must be derived by crushing bedrock where such sources exist.

Crushed Stone

Crushed stone used in construction is derived from a variety of bedrock sources. The larger producers are Diamond Construction Ltd. (greywacke), Forbes and Sloat Ltd. (basalt), Brookville Manufacturing Company (dolomitic limestone), Havelock Lime (limestone), H.E. Carson and Sons Ltd. (metasediment), Moncton Crushed Stone Company Ltd. (granitic gneiss), Acadia Crushed Stone Ltd. (granitic gneiss), MacDonald's Paving and Construction Limited (granitic gneiss), and C.M. Stewart Co. Limited (basalt). (Figure 3)

Sand and Gravel

Sand and gravel are produced from a wide variety of glacial deposits (Figure 24). They are often classified according to depositional conditions, which frequently aid in evaluating potential uses. Five granular aggregate deposit types predominate in New Brunswick. The general characteristics of these deposit types are described below with an assessement of their aggregate production potential.

ABLATION TILL consists of poorly sorted to largely unsorted material that commonly contains significant amounts of all clast sizes from clay through boulders. It is moderately to poorly compacted. The compaction factor is normally less than that of lodgement till, but may include pockets of better-sorted ice-contact granular material.

Ablation till is considered to be of marginal quality due to its high content of fine particles. In its pit-run state, it is used as borrow or subgrade material but not as higher-specification aggregate.

ICE-CONTACT STRATIFIED DRIFT deposits form in contact with glacial ice, either totally confined by it or against the ice front. These deposits characteristically comprise well- to poorly stratified sand and gravel that may include varying amounts of silt and clay. Ice-dropped boulders are common in this material.

Stratification of ice-contact deposits is commonly contorted and faulted. This can often be attributed to slump structures formed when the supporting walls of ice melt, resulting in collapse of the unsupported granular materials, or to compressional stress caused by moving ice. Abrupt changes in grain size and degree of sorting are characteristic of such deposits as well.

Ice-contact stratified deposits as a group include kames, eskers, kame terraces, gravel moraines and other granular bodies of similar origin. The probability of locating coarse granular aggregate material in these features is high, although sand may predominate and much textural variability is to be expected. In many cases, sand and gravel from

FIGURE 24. Brunswick Ready Mix Concrete Ltd. (Aggregate Division) property, 30 km north of Saint John, New Brunswick.

eskers may only require crushing and screening to produce a high-quality aggregate.

GLACIOFLUVIAL OUTWASH deposits consist of material deposited by glacial meltwaters beyond the glacier margin. Depending on the character of the local relief, two major landform types can result from that mode of deposition. If the glacier is confined within steep valley walls, the outwash will similarly be confined and the resulting deposit is known as a valley train. Where there is a wide ice margin, terminating in a broad lowland area, the meltwater streams may spread widely and build up an extensive surface known as an outwash plain. Outwash deltas are built where sediment-laden streams empty into a body of standing water.

The material found in outwash deposits tends to be horizontally bedded and uniform in texture. In an outwash delta, foreset and topset bedding may be observed. The probability of locating suitable granular aggregate in that type of deposit is good.

LACUSTRINE SEDIMENTS are of three principal kinds: delta sediments, bottom sediments, and littoral sediments. Deltas built into glacial lakes are called glaciolacustrine outwash deltas and are akin to the previously described glaciofluvial outwash deltas.

Sediments of lake floors consist of the finer products of glacial

erosion, mainly silt and clay. These fine-grained bottom sediments are sometimes rhythmically laminated, having alternating coarser and finer lamina. Lamina couplets of this kind, which are believed to represent annual cycles of deposition, are termed varves. In the area previously occupied by glacial Lake Madawaska in northwestern New Brunswick, fine sediments are present underneath the alluvial cover.

ANCIENT ALLUVIAL DEPOSITS also occur as terraces in the major valleys in New Brunswick, but stand at levels below those of the deltaic terraces. They are post-glacial features. Much of the component material is reworked from the deltaic deposits by fluvial erosion and redeposition, and thus shows evidence of greater sedimentary maturity, such as better rounding of clasts and a relatively high content of resistant lithotypes.

The ancient alluvial materials are observed in some areas to be medium-pebble to medium-cobble gravels which are cleaner than most other granular deposits. In other areas, they are generally shallow and sorting is variable. Here, they are poorly developed and of little importance except as a local source of borrow or fill for the maintenance of forestry roads.

The cost of aggregate is governed mainly by transportation costs. Therefore, the numerous pits located throughout the Province reflect local demand. The larger ones are located close to urban centres.

Assuming an annual demand of about 12 000 000 t, New Brunswick is expected to have sufficient reserves of sand and gravel for the foreseeable future, although there are shortages in some areas of the Province. These shortages will continue to be met by transporting aggregate from deposits in other areas.

SHALE AND CLAY PRODUCTS

Although shale is crushed in several parts of the Province for use as borrow and general fill, there are only two producers that presently utilize quantities of shale. Lafarge Canada Inc. uses shale to manufacture cement and L.E. Shaw Limited of Chipman, east of Fredericton, manufactures brick from the shale (Figure 3).

The shale used by L.E. Shaw Limited is of Pennsylvanian age and is of a highly plastic nature. It fires to give a hard, dense product that is capable of standing the rigours of Canadian winters. The company produces brick, flue liners, and a wide variety of tiles.

In 1987, the value of shale- and clay-related products was $2 850 000 (Cdn)[1].

DIMENSION AND ORNAMENTAL STONE

New Brunswick has long been associated with the production of granite and sandstone, which were once obtained from several quarries in the southern and northern parts of the Province (Figure 14).

Most granite operations were concentrated along the southern edge of the Saint George Batholith, a granitic intrusion of Devonian age located a few kilometres north of the town of St. George (Figure 4A). Many years ago the cut, dressed, and

---

[1] Statistics Canada, 1987.

finished granites were shipped to many parts of the eastern United States and central Canada. Other granite quarries that have operated from time to time are located at Hampstead, Dawson Mountain, Bald Hill (Ledge Road), Digdeguash Lake, Antinouri Lake, and south of Bathurst. At the present time Nelson Monuments Ltd. of Sussex operate the only active quarry at Hampstead (Figure 3). Most of the stone is used for curbing and foundation construction. The granite quarry at Antinouri Lake has also produced a small amount of specialty stone in recent years.

Many sandstone quarries, established within flat-lying to gently dipping Pennsylvanian rocks, were operated in New Brunswick in the late 1800s and early 1900s. The stone, which varies in colour from grey to brown to maroon, has historically been the basic construction material of many large churches, bridges, banks, universities and other public buildings throughout the Province. Many of the "brownstone" buildings of New York City are built with New Brunswick sandstone.

A large number of sandstone quarries were developed in the southeastern part of the Province: near the confluence of the Petitcodiac and Memramcook Rivers, on the Maringouin Peninsula, at Shediac, and at Curryville. In northern New Brunswick, several quarries were located along the Miramichi River. One of the largest is near Quarryville. A number of small quarries were also opened near Stonehaven and Clifton, on the coast east of Bathurst. All of these operations are now dormant.

Smith Cut Stone and Quarries Limited near Shediac remains as the Province's oldest operating sandstone quarry and finishing company. Founded in the early 1800s, the company has had a long history of providing cut sandstone for numerous primary construction and restoration projects in New Brunswick and abroad.

INDUSTRIAL MINERAL RESOURCE MANAGEMENT

In New Brunswick, a statutory distinction is made between minerals and surficial materials such as sand, gravel, ordinary stone, building or construction stone, and peat. Consequently, the right to extract the respective materials is governed by two separate statutes: the Mining Act and the Quarriable Substances Act.

Both the Mining Act and Quarriable Substances Act are administered by the Department of Natural Resources and Energy.

MINERALS

All minerals in about 97% of the Province are owned by the Province. In the remainder of the Province, landowners retain mineral rights obtained through the original "king's land grants." Exclusive rights to explore, develop, and produce from privately owned lands and those lands managed by the Crown are gained under the conditions determined by the Province's Mining Act (and regulations) depending upon whether the material fits the definition of "mineral" as stated in the Act. The Act defines "mineral" as any natural, solid, inorganic or fossilized organic substance and such other substances as are prescribed by regulation to be minerals, but does not include:

(a) sand, gravel, clay, or soil unless it is to be used for its chemical or special physical properties, or both, or where it is

taken for contained minerals,

(b) ordinary stone used for building or construction,

(c) peat or peat moss,

(d) bituminous shale, oil shale, albertite, or intimately associated substances or products derived therefrom,

(e) oil or natural gas, or

(f) such other substances as are prescribed by regulation not to be minerals.

Most rights under the Mining Act are obtained by staking mineral claims on lands open for staking; however, under certain circumstances special agreements with the Province are arranged for large areas requiring temporary "protection" or for lands withdrawn from staking, prior to the establishment of mining leases (e.g., salt, potash and coal). A summary of mining rights under New Brunswick's Mining Act is presented in Table 1.

AGGREGATE AND PEAT

The ownership of aggregate and peat in New Brunswick is vested in the landowner who controls extraction, providing that legislation pertaining to the environment and employment safety standards are met.

The private sector owns roughly 55% of the Province's land while the Crown in the right of the Province owns roughly 45%. Most of the source and market areas for aggregate are located in the areas where early settlers obtained land grants (e.g., river valleys). Consequently, 80-85% of the sites producing sand, gravel, and crushed stone are located on privately owned land. In contrast, approximately 70% of the producing peatlands in the Province are owned by the Crown.

The Quarriable Substances Act (and regulations) applies to the extraction, under permit or lease, of quarriable substances from all Crown lands and designated shore areas that lie outside Crown lands. Under the Act, a quarriable substance is defined as: ordinary stone, building or construction stone, sand, gravel, peat, peat moss, clay, and soil.

Under the Quarriable Substances Act, the Minister of Natural Resources and Energy may issue:

(a) a quarry permit covering an area on Crown land for a period of 12 months and a designated fee; or

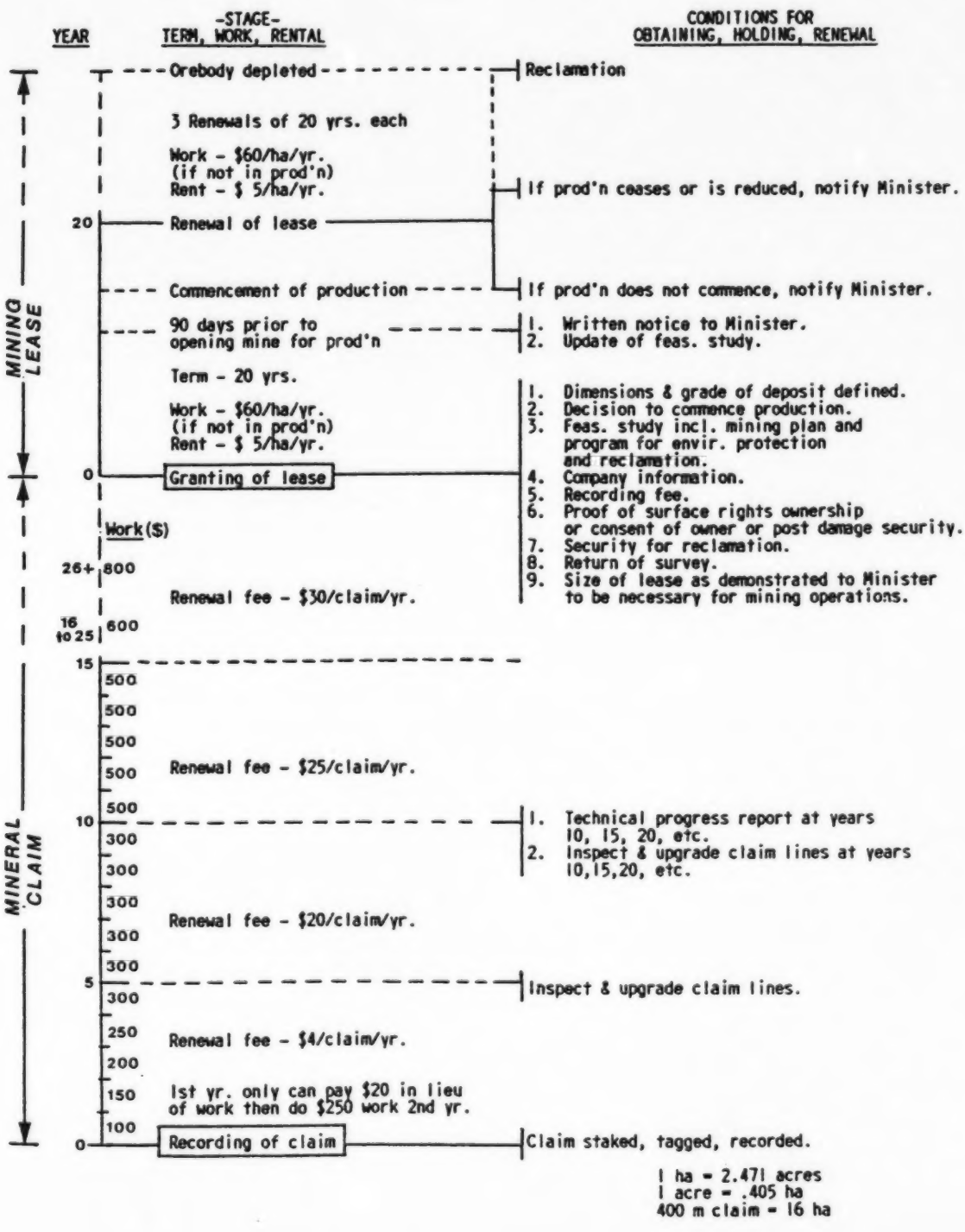
(b) a quarry lease for a maximum of 21 years, but usually issued for 5 years subject to renewal.

A quarry lease grants the lessee exclusive use of the land for the purpose of removing the stated material, whereas a quarry permit only grants permission for removal of the stated amount and does not grant exclusive use (i.e., more than one quarry permit can be issued on a pit provided conditions such as the size of the working face allow it). Both quarry permits and leases are subject to such terms and conditions as prescribed by the Minister.

Applications for a quarry permit within a "shore area", i.e., within 300 m of the mean high tide mark, generally do not receive approval.

In New Brunswick, ownership of peat moss rests with the landowner. Because 70% (47 000 ha) of the peatland area having more than 1 m of peat is located on Crown lands, the Provincial government has taken an active role in defining a management policy to control the development of this important resource. The objectives of the Crown Peat Resources Management Policy adopted in 1979 are to maximize the contribution of the resource to the economic development of the Province and to encourage development in a manner that will not jeopardize future utilization or rehabilitation of

TABLE 1.
The Mining Act of New Brunswick: Summary of Mining Rights.



the peatlands.

A peat lease is required to harvest peat from Crown lands in New Brunswick. To obtain a peat lease, it is first necessary to acquire a peatland exploration licence. This licence reserves an area of up to 800 ha to allow the applicant sufficient time to ascertain that the quality and amount of peat in the proposed lease is suitable for the intended use. Providing that all requirements are met, the exploration licence can be renewable annually to a maximum of three years. The issuance of a Peatland Exploration Licence is an extremely important step in obtaining a lease. It is granted only if the applicant:

(1) has no other licence in effect;

(2) can demonstrate that the proposed development will not adversely affect the future availability of peat for an existing leaseholder; and

(3) can market the product without jeopardizing the existing industry in the Province.

After determining the portion of the exploration area best suited for the proposed use, the applicant may then apply for a peat lease of 250 ha. The applicant must include a drainage plan, a harvesting and future expansion plan, and an abandonment plan. If all requirements are met, a lease can be granted for a period of 10 years. Renewal for additional 10-year periods is possible if certain minimum production requirements and other conditions are met. A security deposit is required to ensure compliance with production and abandonment plans.

The size and term of a lease were designed to avoid the holding and under-utilization of large tracts of peatlands for extended period of time.

Since its inception in 1979, the Crown Peat Resource Management Policy has demonstrated its usefulness in application.

APPENDIX 1.

Minerals and Energy Division Staff
who can Provide Information on
Industrial Mineral Resources and Development Opportunities
in New Brunswick

APPENDIX 1.

Minerals and Energy Division Staff
who can Provide Information on
Industrial Mineral Resources and Development Opportunities
in New Brunswick

Timothy C. Webb, M.Sc.
Industrial Minerals Geologist

Department of Natural Resources and Energy

Minerals and Energy Division
P.O. Box 6000
Fredericton, N.B. E3B 5H1

(506) 453-2206

INDUSTRIAL MINERALS

Jacques J. Thibault
Géologue du Quaternaire

Ministère des Ressources naturelles et de l'Énergie

Division des minéraux et de l'énergie
C.P. 6000
Fredericton (N.-B.) E3B 5H1
(506) 453-2206

PEAT

Allen A. Seaman, M.Sc, F.G.A.C.
Quaternary Geologist

Department of Natural Resources and Energy

Minerals and Energy Division
P.O. Box 6000
Fredericton, N.B. E3B 5H1

(506) 453-2206

SAND AND GRAVEL RESOURCES

J. DEAN THIBAULT
Process Engineer

Department of Natural Resources and Energy

Minerals and Energy Division
P.O. Box 6000
Fredericton, N.B. E3B 5H1

(506) 453-2206

MINERAL PROCESSING

Natural Resources and Energy / Ressources naturelles et Énergie

Don J. J. Carroll
Co-ordinator, Geoscience Data Section
Geological Surveys Branch
P.O. Box 6000, Fredericton, N.B. E3B 5H1
Tel.: 506-453-2206

Hugh John Flemming Forestry Centre

GEOSCIENCE PUBLICATIONS

APPENDIX 2.

Producers and Potential Producers of Industrial Minerals in New Brunswick

PRODUCERS AND POTENTIAL PRODUCERS OF INDUSTRIAL MINERALS IN NEW BRUNSWICK

COMPANY, ADDRESS, AND TELEPHONE NUMBER	PARENT COMPANY	MANAGER	ENGINEER	PRODUCTS	TYPE OF MINE AND STAGE
Brookville Manufacturing Company Ltd. P. O. Box 2332 Postal Sta. C. Saint John, N.B. E2L 3V6 - 633-1200	R.H. Oland	M. Sanford		Lime, Construction Stone	Quarry, Active Producer
Lafarge Canada Inc. R.R. # 1 Havelock, N.B. E0A 1W0 - 534-2301		H. Kierstead		Aggregate	Quarry, Active Producer
Denison-Potacan Potash Company P.O. Box 5005 Sussex, N.B. E0E 1P0 - 839-2146	Denison 60% Potacan 40%	I. Duke	D.C.E. Waugh	Potash	Underground, Active Producer
Chaleur Silica Limited Box 4, Site 4 Petit Rocher, N.B. E0B 2E0 - 783-2387		J.C. Godin		Smelter Flux, Silica Sand	Quarry, Active Producer
BP Resources Canada Limited (Selco Division) P.O. Box 940 Sussex, N.B. E0E 1P0 - 433-5814		J. Hainey	K.B. Crosby	Potash	Surface Exploration
Havelock Lime P.O. Box 59 Havelock, N.B. E0A 1W0 - 534-2311	Dickenson Mines Ltd.	L. Murray	A. Van Agten	Calcined and Hydrated Lime, Agricultural Lime	Quarry, Active Producer
Potash Company of America, Inc. P.O. Box 1489 Sussex, N.B. E0E 1P0 - 433-5445	Rio Algom Ltd.	D. Roberts	W.C. Rogers	Potash, Salt	Underground, Active Producer
Elmtree Resources Ltd. P.O. Box 665 Bathurst, N.B. E2A 3Z6 - 546-6382		A. Buzas	G.M. Doucet	Limestone, Smelter Flux	Quarry, Active Producer

() potential product

COMPANY, ADDRESS, AND TELEPHONE NUMBER	PARENT COMPANY	MANAGER	ENGINEER	PRODUCTS	TYPE OF MINE AND STAGE
Upper Kent Lime Works Ltd. R.R. # 3 Bath, N.B. E0J 1E0 - 278-5359		D. Lloyd		Marl	Open Pit, Active Producer
Nelson Monuments Ltd. P.O. Box 1220 23 Western St. Sussex, N.B. E0E 1P0 - 433-3413		E. Nelson M. Nelson		Monuments, Cut-Granite Curbing	Quarry, Active Producer
L.E. Shaw Limited P.O. Box 188 Chipman, N.B. E0E 1C0 - 339-6604		G. Roberts		Brick, Clay, Flue Liners, Drain Tiles	Quarry, Active Producer
Smith Cut Stone & Quarries Limited P.O. Box 69 Shediac, N.B. E0A 3G0 - 532-6902		R. LeBlanc		Building Stone & Shaped Granite	Quarry, Active Producer
Sussex Silica Inc. R.R. # 3 Sussex, N.B. E0E 1P0 - 433-5890		R. Turner		Silica: High Purity Lump & Sand	Open Pit, Active
Acadian Peat Moss (1979) Ltd. P.O. Box 240 Lamèque, N.B. E0B 1V0 - 344-2225		E. Chiasson		Peat Moss	Bog, Active
ASB Greenworld Ltd. Pointe-Sapin, N.B. E0A 2A0 - 876-3937		A. Avenriep		Peat Moss	Bog, Active
Chiasson Peat Moss Ltd. P.O. Box 112 Lamèque, N.B. E0B 1V0 - 344-2426		G. Haché		Peat Moss	Bog, Active
Atkins and Durbrow (N.B.) Ltd. P.O. Box 98 Bas-Caraquet, N.B. E0B 1E0 - 727-3385		E. Kivipato		Peat Moss	Bog, Active
Fafard Peat Moss Co. Ltd. P.O. Box 70 Shippagan, N.B. E0B 2P0 - 336-2325		R. Martin		Peat Moss	Bog, Active

COMPANY, ADDRESS, AND TELEPHONE NUMBER	PARENT COMPANY	MANAGER	ENGINEER	PRODUCTS	TYPE OF MINE AND STAGE
Grande-Anse Peat Moss Co. Ltd. P.O. Box 90 Grande-Anse, N.B. E0B 1R0 - 732-2854		P. Whelton		Peat Moss	Bog, Active
Heveco Ltd. P.O. Box 30 Tabusintac, N.B. E0C 2A0 - 779-9277		M. Wishart		Peat Moss	Bog, Active
Lamèque Peat Moss Ltd. P.O. Box 570 Lamèque, N.B. E0B 1V0 - 344-2293		F. Chiasson		Peat Moss	Bog, Active
Pigeon Hill Peat Moss Ltd. P.O. Box 639 Lamèque, N.B. E0B 1V0 - 344-2440		E. Chiasson		Peat Moss	Bog, Active
St.-Raphael Peat Moss Ltd. P.O. Box 570 Haut-Lamèque, N.B. E0B 1V0 - 344-7058		F. Chiasson		Peat Moss	Bog, Active
Canadian Supreme Products Ltd. P.O. Box 570 Lamèque, N.B. E0B 1V0 - 344-2293 - 395-2215 (Plant)		L. Chiasson		Peat Moss	Bog, Active
Theriault and Hachey Peat Moss Ltd. R.R. # 1 Baie-Sainte-Anne, N.B E0C 1A0 - 228-4530		I. Theriault		Peat Moss	Bog, Active
Fisons Western Corporation Maisonnette, N.B. E0B 1X0 - 727-3428		E. Puhacz		Peat Moss	Bog, Active
Kent Peat Moss Ltd. P.O. Box 70 Shippagan, N.B. E0B 2P0 - 336-2325 (H.O.) - 955-3098 (Plant)	Fafard Peat Moss Co. Ltd.	E. Maillet		Peat Moss	Bog, Active

COMPANY, ADDRESS, AND TELEPHONE NUMBER	PARENT COMPANY	MANAGER	ENGINEER	PRODUCTS	TYPE OF MINE AND STAGE
Burnt Church Peat Moss Co. Ltd. P.O. Box 78 Shippagan, N.B. EOB 2PO - 336-2312		J. Mourant		(Peat Moss)	Bog, Development
Good Earth Canada Ltd. 5960 Broadway Lancaster, N.Y. 14086 U.S.A. - (716) 684-8111 (H.O.) - (506) 220-3205 (Plant - Escuminac)		G. Burkhardt		Peat Moss	Bog, Active
Malpec Peat Moss Ltd. P.O. Box 118 Rexton, N.B. EOA 1LO - 523-9161		S. Currie		Peat Moss	Bog, Active
Berger Mix Inc. 121, R.R. # 1 (Comté de Rivière-du-Loup) St-Modeste, Que. GOL 3WO - (418) 862-4462		C. Berger		Peat Moss	Bog, Active
Jiffy Products (N.B.) Ltd. P.O. Box 360 Shippagan (N.B) EOB 2PO (506) 336-2284		A. Dupuis		Peat Pots and Pellets	Manufacturing Plant
Brunswick Ready-Mix Concrete Ltd. (Aggregate Division) P.O. Box 270 Grand Bay, N.B. EOG 1WO - 757-8657	Brunswick Ready Mix Concrete Ltd.	E. Pond		Granular Aggregate, Gravel	Open Pit, Active Producer
Forbes and Sloat Ltd. P.O. Box 273 654 Union St. Fredericton, N.B. E3A 3N7 - 472-6242		R. Forbes		Crushed Stone	Quarry, Active Producer
Diamond Construction (1961) Ltd. P.O. Box 2100 Frdericton, N.B. E3B 4Y6 - 542-0044		L. Ashfield		Crushed Stone	Quarry, Active Producer

() potential product

COMPANY, ADDRESS, AND TELEPHONE NUMBER	PARENT COMPANY	MANAGER	ENGINEER	PRODUCTS	TYPE OF MINE AND STAGE
H.E. Carson and Sons Ltd. 1 Carson Drive Moncton, N.B. E1C 4K1 - 384-8991		G. Carson		Crushed Stone	Quarry, Active Producer
MacDonald Paving and Construction Limited P.O. Box 458 181 McAleese Lane Moncton, N.B. E1C 8L9 - 857-2805		R. MacDonald		Crushed Stone	Quarry, Active Producer
Moncton Crushed Stone Company Ltd. P.O. Box 5000 Salisbury Road Moncton, N.B. E1C 8R2 - 853-8861	Modern Enterprises Ltd.	W. Chambers		Crushed Stone	Quarry, Active Producer
Acadia Crushed Stone Ltd. P.O. Box 5000 Salisbury Road Moncton, N.B. E1C 8R2 - 853-8853	Modern Enterprises Ltd.	W.Chambers		Crushed Stone	Quarry, Active Producer
C.M. Stewart Co. Limited P.O. Box 1210 Dalhousie, N.B. E0K 1B0 - 684-2152		James R.C. Stewart	Same	Crushed Stone	Quarry, Active Producer
Brunswick Mining and and Smelting Corporation Ltd. (Smelter - Fertilizer Division) P.O. Box 2000 Belledune, N.B. E0B 1G0 - 522-2100		M. Street		Sulphur	Smelter. Active Producer